# MAMMALIAN-SIPHONAPTERAN ASSOCIATIONS, THE ENVIRONMENT, AND BIOGEOGRAPHY OF MAMMALS OF SOUTHWESTERN COLOMBIA

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*Quaestiones Entomologicae*
*13: 91-182 1977*

*A synopsis of the fleas and their mammalian hosts in southwestern Colombia, with particular reference to the Departamento del Valle is presented and information about the Siphonaptera of Colombia is reviewed.*

*Descriptions and illustrations of diagnostic features characterize the following new species of* Polygenis *Jordan:* P. caucensis *(Type locality: Alto Anchicayá, Depto. del Valle, COLOMBIA; type host:* Oryzomys caliginosus*),* P. delpontei *(Type locality: Quebrada Honda near Pichindé, Municipio de Cali, Depto. del Valle, COLOMBIA; type host:* Oryzomys caliginosus*),* P. hopkinsi *(Type locality: Peña del Cerro, Cerro Munchique, Depto. del Cauca, COLOMBIA; type host:* Oryzomys albigularis*),* P. trapidoi *(Type locality: Valle del Rio Pichindé, Municipio de Cali, Depto. del Valle, COLOMBIA; type host:* Oryzomys caliginosus*). In addition, descriptions are given of the male of* Ctenidiosomus traubi *Johnson, and the female of* Sphinctosylla diomedes *Johnson. The former species was previously known from the female, and the latter species was originally described from the male. The following taxa are reported for the Republic of Colombia for the first time:* Plocopsylla phyllisae *Johnson,* Leptopsylla segnis *(Schönherr),* Dasypsyllus gallinulae peripinnatus *(Baker),* Tetrapsyllus comis *Jordan,* Polygenis pradoi *(Wagner),* P. thurmani *Johnson,* P. klagesi samuelis *(Jordan and Rothschild), and* Pulex simulans *(Baker).*

*The taxon* Rhynchopsyllus megastigmata *Traub and Gammons, 1958, is considered to be conspecific with* Rhynchopsyllus pulex *Haller, 1895.*

*Records contained herein bring the total number of known Colombian Siphonaptera to at least 44 species and subspecies. Of this number, more than two-thirds are reported from the southwestern part of the country.*

*A key to the fleas of southwestern Colombia, and illustrations of diagnostic features of most of the taxa are included.*

*An account is given of the history and zoogeography of the mammalian fauna of southwestern Colombia, as well as comments on host-parasite relationships. The history of the mammalian fauna of South America was probably initiated at the beginning of the Tertiary. This early fauna included marsupials, certain edentates and primtive ungulates that came from North America. Subsequent isolation of North America from South America interrupted, but not completely stopped, an interchange of animals by island-hopping. The faunal interchange was re-established when the Isthmian land bridge appeared at the end of the Tertiary. It is also possible that during the Cretaceous and early Tertiary, South America received faunal elements from Africa and from Australia.*

*The majority of families and genera of South American mammals originated during periods of total or incomplete isolation. Presently, in the Pacific Coastal Lowlands of Colombia ubiquitous mammals outnumber endemic forms. This fauna has strong affinities with those of the Amazon Region and the coastal lands of Panamá and Ecuador. The remaining taxa of the southwest portion of Colombia are more concentrated in the Andes and include some forms that probably originated in the lowlands.*

*Evolution and radiation of the fleas of this territory probably was correlated to evolution*

of their hosts. This phenomenon is more apparent in fleas parasitizing small mammals, such as cricetine rodents. The lowland flea fauna of the Pacific sector is particularly poor, both in numbers of taxa and endemism, while that of the Andean mountains displays more local elements in addition to being significantly diversified. The Southwestern Colombia flea fauna exhibits little specificity and various species may parasitize the same host. On the other hand, there are related and unrelated host species that harbor the same flea taxon. It is evident that the flea fauna of the Colombian Pacific lowlands is related to those of Panamá and the Amazon and Orinoco basins. The strong mammalian relationship existing throughout the Andean Cordillera in Colombia and Ecuador is reflected in the affinity observed in the flea fauna.

Geographic aspects, such as topography, geology, soil, climate and vegetation concerned with the pertinent biota are discussed. Southwestern Colombia is characterized by a diversity of ecological situations resulting from a complex topography and the concomitant climatic regimes. The Pacific Coastal lands, and the Andean highlands, in addition to the Cauca Valley, represent the major geographic areas of this territory.

Se presenta un sumario de la fauna de sifonápteros y sus mamíferos hospederos en la región suroccidental de Colombia, principalmente en el Departamento del Valle; al mismo tiempo, se revisa la información existente sobre las pulgas de Colombia.

Se incluyen descripciones e ilustraciones de aspectos diagnósticos que caraceterizan las siguientes especies nuevas del género Polygenis *Jordan:* P. caucensis *(Localidad tipo: Alto Anchicayá, Depto. del Valle, COLOMBIA; hospedero tipo:* Oryzomys caliginosus*)*, P. delpontei *(Localidad tipo: Quebrada Honda, cerca de Pichindé, Municipio de Cali, Depto. del Valle, COLOMBIA; hospedero tipo:* Oryzomys caliginosus*)*, P. hopkinsi *(Localidad tipo: Peña del Cerro, Cerro Munchique, Depto. del Cauca, COLOMBIA; hospedero tipo:* Oryzomys albigularis*)*, P. trapidoi *(Localidad tipo: Valle del Rio Pichindé, Municipio de Cali, Depto. del Valle, COLOMBIA: hospedero tipo:* Oryzomys caliginosus*). Además, se describen en este trabajo el macho de* Ctenidiosomus traubi *Johnson y la hembra de* Sphinctopsylla diomedes *Johnson. De la primera especie únicamente se conicia la hembra, mientras que la segunda especie se describió originalmente del macho. Los siguientes taxa son citados por vez primera para la República de Colombia:* Plocopsylla phyllisae *Johnson,* Leptopsylla segnis *(Schönherr),* Dasypsyllus gallinulae perpinnatus *(Baker),* Tetrapsyllus comis *Jordan,* Polygenis pradoi *(Wagner),* P. thurmani *Johnson,* P. klagesi samuelis *(Jordan and Rothschild), and* Pulex simulans *(Baker).*

*El taxon* Rhynchopsyllus megastigmata *Traub & Gammons, 1958, es considerado sinónimo de* Rhynchopsyllus pulex *Haller, 1895.*

*Los registros contenidos en este trabajo permiten estimar que cerca de cuarenta y cuatro especies y subespecies de pulgas son conocidas de Colombia y que de este número más de dos tercios están citadas para la parte suroccidental del país.*

*Se incluye una clave para separar las pulgas del soroeste de Colombia y se ilustran aspectos diagnósticos de la mayoría de los taxa.*

*Se expone un bosquejo de la historia y zoogeografía de la fauna de mamíferos de la parte suroccidental de Colombia, así como también comentarios sobre las relaciones entre parásitos y hospederos. La historia de la fauna de mamíferos de Sur América probablemente se inició al comienzo del período Terciario. Esta fauna primitiva consistió de marsupiales, ciertos edentados y ungulados primitivos que vinieron de Norte América. El posterior aislamiento entre Norte América y Sur América logró interrumpir pero no detener completamente un intercambio de animales mediante su traslado de isla a isla. El intercambio faunístico fue restablecido cuando apareció el puente Istmeño al final del Terciario. También es posible que durante el período Cretácico y el comienzo del Terciario, Sur América recibió elementos faunísticos de Africa y de Australia.*

*La mayoria de las familias y géneros de mamiferos suramericanos se originaron durante periodos de parcial o total aislamiento. En los tiempos actuales, en las tierras bajas de las costas colombianas del Pacifico aquellos mamiferos de amplia distribución sobrepasan las formas endémicas. Estas faunas tienen una fuerte afinidad con aquellas de la región amazónica y de las tierras costeras de Panamá y Ecuador. Las restantes formas de la porción suroeste de Colombia están más concentradas en los Andes y contienen algunos elementos que probablemente se originaron en las tierras bajas.*

*La evolución y radiación de las pulgas de este territorio probablemente estaban correlacionadas con aquellas de sus hospederos. Este fenómeno parece ser más aparente en las pulgas que parasitan mamíferos pequeños, tales como los roedores cricetinos. La fauna de pulgas del sector Pacífico es particularmente pobre, tanto en composición como en endemismo; mientras que aquella de las montañas Andinas muestra más elementos locales además de estar apreciablemente diversificada. La fauna de pulgas del suroeste de Colombia exhibe poca especificidad y varias especies pueden parasitar el mismo hospedero. Por otra parte, existen especies de hospederos relacionados y no relacionados que comparten el mismo taxon de pulga. Es evidente que la fauna de pulgas de las tierras bajas del Pacífico colombiano están relacionadas con las de Panamá y las cuencas de los ríos Amazona y Orinoco. La fuerte relación de los mamíferos existentes a traves de las cordilleras Andinas en Colombia y Ecuador, se refleja en la afinidad que se observa en la fauna de pulgas.*

*Se discuten también en este trabajo aspectos geográficos tales como topografía, geología, suelo, clima y vegetación que conciernen al pertinente biota. El suroeste de Colombia se caracteriza por una diversidad de situaciones ecológicas que*

*resultan de una topografía compleja y los regímenes climáticos concomitantes. Las tierras costeras del Pacifico y las elevadas tierras Andinas, además del Valle del Cauca, representan las principales áreas geográficas de este territorio.*

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## INTRODUCTION

The Departamento del Valle, one of several political divisions of the Republic of Colombia, comprises an area of about 20,430 km$^2$, located in the southwest sector of that country. It contains contrasting ecological situations, including very wet rainforest of the Pacific lowlands, western and eastern slopes of the Cordillera Occidental, basin of the Rio Cauca in the rainshadow of Cordillera Occidental at 1000 meters, and the ascending western slope of the high Andean Cordillera Central. This territory is bordered on the north by the departamentos del Choco and Risaralda, on the south by the Departamento del Cauca, on the east by the departamentos del Tolima and Quindio, and on the west by the Pacific Ocean.

The Departamento del Valle contains a great variety of plant and animal life, representing more than half of the total number of species of mammals known to occur in Colombia. There is little information about the fauna and the importance that many of these animals have as positive or negative elements in the health of humans and domesticated animals. This need for basic research in biology is indicative of the whole of Colombia as well as other areas of South America.

During the past two decades, the Universidad del Valle, in conjunction with the Rockefeller Foundation and the Tulane University International Center for Medical Research, have contributed significantly to knowledge of arthropods and mammals associated with zoonoses in Colombia (Cali Virus Laboratory, 1965, 1968, 1970). Through the study of ectoparasites collected by these research units, an interest developed for investigation of fleas and their mammalian hosts in the Departamento del Valle and other regions of Colombia.

The importance of fleas in the epidemiology of plague, murine typhus and other diseases is well known, thus primary consideration of these medically important arthropods is warranted. In some instances, knowledge of the ectoparasitic fauna of an area may also provide understanding of relationships among animal host groups (Clay, 1951; Hopkins, 1942; Patterson, 1957). Although plague, which remains a major concern, has not yet been found in Colombia, it is present in the adjacent countries of Ecuador, Venezuela, Perú and Brazil. There is, however, a strong possibility that the disease could become established in Colombia, since ideal climatic factors occur in many areas of the country. In addition, both wild rodent species and those commensal with man are present; these have been implicated elsewhere either as actual or potential reservoirs of plague. Several species of fleas occurring in Colombia, such as *Xenopsylla cheopis*, the classical vector of plague, as well as *Pulex irritans* and certain species of *Polygenis*, have been implicated in transmission of plague in other countries (Chabaud, 1947;

Macchiavello, 1948, 1954, 1958; Moll and O'Leary, 1945; Panamerican Health Organization, 1956; Pollitzer, 1954).

Presently, the Siphonaptera fauna of Colombia is poorly known. In a survey prior to beginning this study, I found that Colombian material was not well represented in collections of several institutions, including the British Museum (Natural History) and the United States National Museum of Natural History.

The literature contains few reports concerning Siphonaptera from Colombia. Dunn (1929) and Patiño-Camargo (1940) briefly mention some common species. Fuller (1942) and Macchiavello (1948) gave several Colombian records of fleas. Costa Lima and Hathaway (1946) present information on several Colombian species. Gast Galvis (1950) in his list of fleas from Colombia considered 19 species and subspecies. Johnson (1954 and 1957) has most significantly contributed to our knowledge of the fleas of Colombia. In 1954, she described a new species of *Pleochaetis* from that country. Her outstanding monograph "Fleas of South America", published in 1957, contains several new distributional records of species for Colombia and, in addition, the description of six new species. Méndez (1968) described a new genus and species of Colombian flea, and more recently, Méndez and Hanssen (1975) reported a new Colombian taxon discovered in the Departamento del Meta. Tamsitt and I. Fox (1970) recorded *Rhynchopsyllus pulex* Haller.

This work is largely based on information obtained from collections made in the Departamento del Valle and neighboring political divisions of southwestern Colombia, such as Nariño, Cauca, Putumayo and Huila. In view of the ecological affinities of these territories and the similarity of their mammalian fauna, it is likely that these areas have virtually the same ectoparasitic fauna.

The present account contains descriptions of four new species of *Polygenis* Jordan. The female of *Sphinctopsylla diomedes* Johnson, known previously from the male, and the male of *Ctenidiosomus traubi* Johnson, are also described. A key to species of fleas known or presumptively existing in the southwestern portion of Colombia, and new records for the country, are also presented. *Rhynchopsyllus megastigmata* Traub and Gammons is considered here to be a synonym of *R. pulex* Haller. Conventional figures for the majority of the species concerned are included.

The nucleus of the material was from collections made by Harold Trapido while engaged in virus research sponsored by the Rockefeller Foundation. Additional specimens were collected personally or obtained from the Universidad del Valle and other sources.

## PHYSICAL ENVIRONMENT OF THE DEPARTAMENTO DEL VALLE

### Topography

Inasmuch as most of the siphonapteran material used in this study is from the Departamento del Valle, the following geographical discussion is limited to this territory. No other political division of Colombia displays such a diversity of geographic features and, consequently, ecological conditions. The topographic information given below is derived mainly from Espinal (1968), Sánchez (1965) and Sauer (1950).

Generally, the physiographic and faunistic elements of this area are characteristic of the southwestern zone of Colombia, which consists of the Cauca Valley territory, surrounding mountains, and Pacific coastline within the limits of the Departamentos del Valle, Cauca, Huila, Nariño, and Putumayo.

The landscape is dominated by the Western and Central ranges of the Andean mountain system. These mountains contain some of the higher peaks of Colombia. The Western Cordillera extends north-northeastward parallel to Central Cordillera and is almost parallel to the


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Fig. 1. Map of Colombia.

Pacific coast. It is the lowest of the three ranges forming the Andean system. The Central Cordillera in the eastern sector of El Valle contains high peaks such as the mountains of Huila and Barragán, which exceed 3000 meters.

Several rivers and numerous streams form a Pacific watershed which originates in the mountains and empties into the Pacific Ocean. The more important rivers are the Anchicayá, Dagua, Naya and Cauca. This last river is the largest and courses through the Departamento from south to north.

Mangrove swamps flooded by high tides are along the shoreline of the Pacific coasts. Warm tropical rain forests follow the swamps and occupy extensive inland zones of dense vegetation, which is impenetrable in many areas. The rich plant life, water, and cover, offer optimal conditions for an abundance of animal forms. The pocket-like arid valley of Dagua, however, with its grassy and brushy cover, introduces a contrasting zone in this lowland territory.

A subtropical zone of humid temperate climate follows the lowland cloud forests. This temperate zone is characteristic of the middle slopes of the mountains, where vegetation is rich but not very luxuriant. Many of the faunal elements of these subtropical forests are similar to those found in lowlands, since many species evolved from ancestors which moved to the upper zones. Apparently climate and other geographical conditions have been limiting factors in establishment of some species that have more restricted tolerances.

The Cauca Valley, an agriculture area of the temperate zone, is a narrow isolated region consisting of approximately 400,000 hectares between the Western and Central Cordillera. It is nearly 160 kilometers long and only 12 kilometers wide, and is drained by the Cauca River. Although much of its territory is occupied by pasture, mainly Para (*Panicum barbinode*) and Guinea (*P. maximum*) grasses, the Cauca Valley represents the most fertile and productive agricultural land of Colombia.

Lush montane cloud forests occupy extensive zones of moderate and high elevations (from below 1000 to about 3000 meters) throughout most of the Central and Western Cordilleras. The uppermost reaches of the mountains, from over 3000 meters, are largely unforested, consisting primarily of extensive grass plains characteristic of paramos (such as Las Hermosas, Chinche, Miraflores and Barragán). These areas support more selected types of plants and animals; indeed the paucity of animal life in the paramos is directly correlated to the poor diversity of cover.

As in other areas of Colombia, the Departamento del Valle is suffering from much deforestation, due primarily to agricultural development, hydroelectric projects and raising of cattle.

## Geology

By virtue of its rock composition, Colombia comprises two geological regions: the Oriental plains; and the Andean geosynclinal regions (Bürgl, 1961). Only the latter region is in southwestern Colombia, including the Departamento del Valle. The vast Oriental plains are in east and southeastern Colombia.

The Andean geological region was apparently submerged during long periods from the beginning of the Cretaceous, and accumulated large deposits of marine, continental and volcanic sediment. The complicated tectonic movements experienced by these lands were responsible for formation of the present Andean Mountains, which constitute the "backbone" of Colombia.

The Andean geosynclinal region was consolidated before the Cambrian period, and includes the following mountain systems: 1. Central Cordillera, 2. Western Cordillera and Coastal Cordillera (Serranía de Baudó), and 3. Eastern Cordillera. The Lower and Middle Magdalena Valley basins separate the Central and Eastern Cordillera. The Lower Valley contains non-marine

Tertiary rocks, while, the Tertiary reservoirs of the Middle Valley are non-marine. Western and Central Cordilleras are separated by the valleys of the Upper Cauca and Upper Patia rivers. Other mountains of Colombia, such as the Santa Marta Mountains, Perijá Mountains and the Pacific Coast Range, have affinities with the Andean system.

The coastal zone of the Andean Region is represented by the Bolivar Geosyncline, a lowland area of Tertiary Marine formation, west of the Andean mountains and extending from Southern Ecuador to the Gulf of Urabá in northern Colombia. This strip of land has been interpreted as a seaway which apparently permitted movement of terrestrial animals during periods ranging from upper Cretaceous times to Recent (Nygren, 1930; Hershkovitz, 1966). No marine formations from the Upper Cretaceous have been found in this zone.

The Eastern Cordillera displays abundant deposits of Cretaceous and Tertiary rocks, with little or no recent volcanic elements. In addition, Jurassic, Triassic and Paleozoic rocks are found in these mountains. Western and Central Cordilleras, as well as the Pacific Coast Range, are primarily formed of igneous and metamorphic rocks, having only subordinate sedimentary beds. Each Cordillera has several high volcanic peaks.

The Precambrian sedimentary history of Colombia is not known (Jacobs, Bürgl and Conley, 1963). According to these authors, during a great part of Cambrian and Ordovician time, the actual territory of the Eastern and Central Cordilleras, and at least the western aspect of the Llanos and Putumayo-Caqueta lowlands, were occupied by seas. Later, the area came under the influence of volcanic and diastrophic activity, which destroyed the Cambrian-Ordovician marine deposits. Rock shields, characteristic of the Andean system during the Cambrian, apparently were greatly disturbed by erosion and their detritus filled marine and terrestrial depressions of the region. The most important fossils from the lower Paleozoic in Colombia are brachiopods, trilobites and graptolites. The territory west of Central Cordillera shows no indication of Paleozoic marine sediment.

Some Middle Ordovician fossils have been found in Colombia. However, Upper Ordovician and Silurian apparently are not represented by fossiliferous layers in this country.

Fossils from the Devonian of Colombia are represented by brachiopods, bryozoans and trilobites, among other invertebrates. Many plant and animal fossils, primarily marine forms, are known from the Carboniferous.

Evidence obtained from fossils indicates that the lower Carboniferous sea invaded the eastern part of the Andean Region, which was covered by sediment thereafter. During the upper Carboniferous, the sea gradually retreated and large semi-swampy forests moved to sections previously occupied by water. Abundant Permian fossils have been found in only a few areas of Colombia, primarily at Serranía de Perijá. They represent sponges, crinoids, brachiopods, gasteropods, cephalopods, and other marine animals. The eastern portion of the Central Cordillera contains Marine Upper Triassic rock (the Payande Formation), and represents a combination of sandstone, limestone and shale. The Eastern and Central Cordilleras contain lower Jurassic sedimentary rocks, principally of continental origin.

Evidently much igneous activity occurred in the Andean Region during the Mesozoic. Also, it is apparent that the major part of western Colombia was occupied primarily by seas during most of Late Jurassic and Cretaceous time. Fossils from these periods are scant and consist mainly of ammonites and other molluscs. The Cretaceous Colombian and Peruvian faunas displayed a strong relationship with those of Southern Europe (Olsson, 1956). Considerable tectonic movements that occurred during Late Cretaceous and early Tertiary, produced constant changes in the landscape of this region and in the formation of marine and non marine deposits. The Tertiary Continental deposits contain an excellent vertebrate fauna, including numerous mammals. There is also evidence of considerable faulting and folding during the late Paleocene.

Throughout the Eocene, land forms of this area were somewhat different from the present. However, the principal elements of the Andes and the Pacific Coast basin originated during this period, and Weeks (1947) points out that the Bolivar Geosyncline introduced important changes in Western Colombia and Ecuador. Much tectonic and volcanic activity took place during the Eocene and Oligocene (Hammen, 1961; Vuilleumier, 1971). Very few fossil vertebrates of Eocene age are known from Colombia (Stirton, 1953). Layers corresponding to the Eocene and Oligocene are richer in Foraminifera, molluscs and other marine fossils. The Cauca Valley is particularly rich in Oligocene marine rocks, mainly consisting of algal, and foraminiferal limestone. This area also has coal-bearing Tertiary rocks, that probably originated during the Miocene or before.

A large number of fossil vertebrates has been discovered in Miocene deposits. The fossil mammal fauna of this period is very interesting and contains some relics of families believed to have disappeared in earlier times. Numerous findings of mammalian Pleistocene fossils have taken place in Colombia (Stirton, 1953; Patterson and Pascual, 1968). Many of these fossils represent species that became extinct at the end of the Pleistocene. Jacobs, Bürgl and Conley (1963) consider that the most recent stage of tectonic movement and volcanic activity was initiated in the early Miocene and continued into Recent time, particularly affecting the Central Cordillera and the southernmost part of the Western Cordillera. Some of the volcanoes existing today are still active.

## Soils

The following considerations of soil distribution in the Departamento del Valle are based primarily on two major sources: the FAO/UNESCO Soil Map of South America (1961), and the account by Beek and Bramao (1968).

A great deal of work has been done in South America to determine distribution of major soils as important patterns in development of agricultural zones and exploitation of minerals and other natural resources significant to the general economic progress of the continent. However, despite the knowledge that has been accumulated during many years, the study of structure, composition, and distribution of South American soils is far from complete.

The nature of the soils of the Departamento del Valle is linked to patterns of ecological factors that govern the life zones, such as climate, geomorphology, topography, and vegetation. Departamento del Valle, and other areas of southwestern Colombia, from which material used in the present study has been collected, consist of Lowlands and Andes soils, two of the major structural elements of soil distribution that have been established for South America. Uplands soils, the other element considered in this segregation, are found in the eastern part of South America. Criteria assumed for establishment of these general categories are based on a complex association of factors such as geography, climate, vegetation, physiography, etc.

The Pacific Coastal Lowlands form a high portion of the western side of the Departamento and are primarily characterized by contiguous areas of tropical evergreen and deciduous forests. The alluvial soils predominating in this territory are stratified with little organic matter and little profile development. The Pacific littoral is particularly dominated by dense mangrove forests, interspersed with swamp forests. This zone contains Quaternary marine and fluviomarine deposits with alluvial plains and terraces, estuarine and delta alluvial deposits, and local areas of coastal sand dunes.

The Northern Andes is the other soil region of the Departamento del Valle. The soil composition is more diverse and the profile of the area interrupted by western and central ranges of the Andean mountains. These are separated by the Cauca Valley, a strip of land which also includes areas of the Departamento de Cauca, Nariño, Caldas and Antioquia.

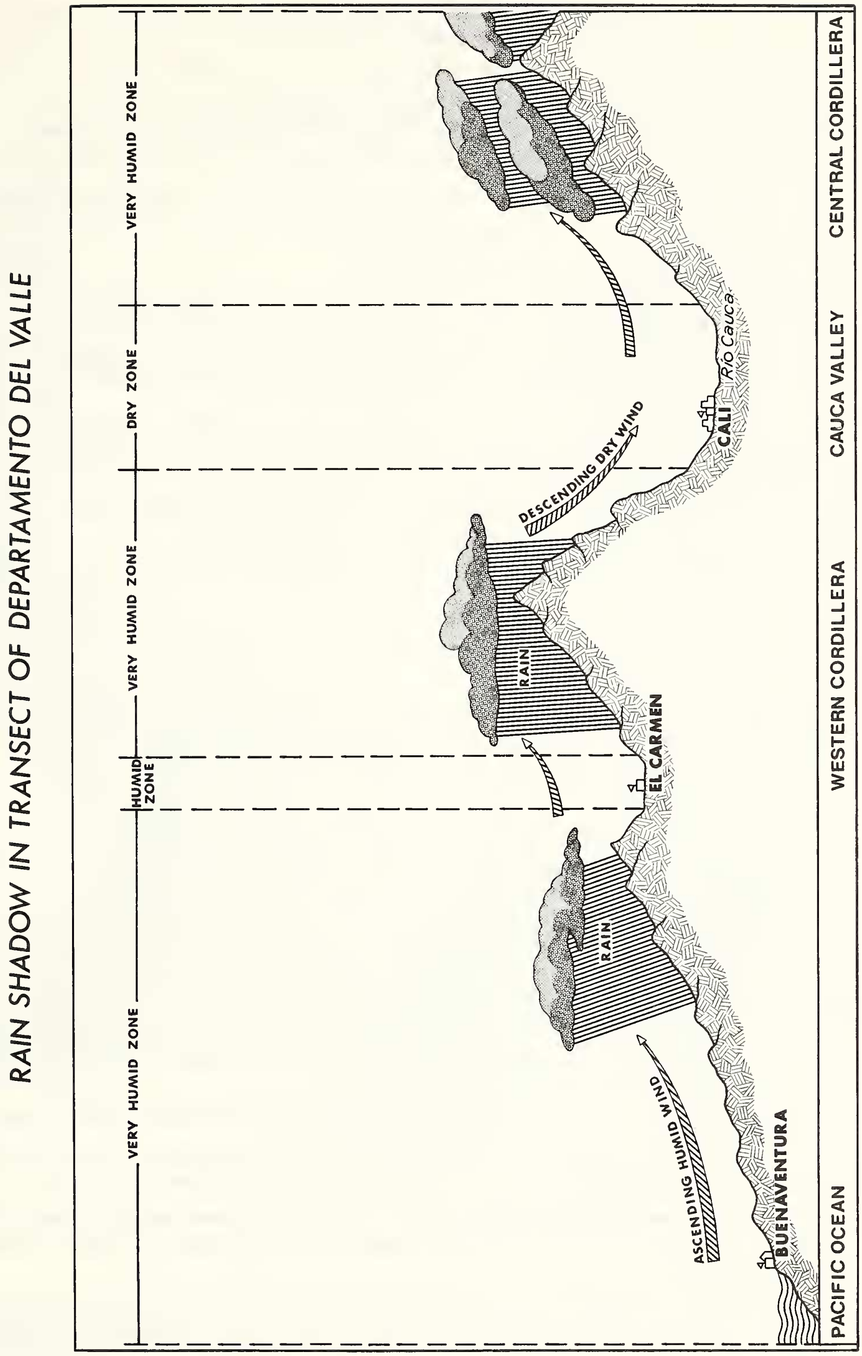


Fig. 2. Rainshadow in transect of Departamento del Valle.

In the western sector of the Northern Andes region of the Departamento del Valle, volcanic rocks are the most important elements of the soil structure. This condition reflects the volcanic origin of these mountains. Most soils in areas of moderate elevation in the northern Andes are Laterosols, derived from volcanic material. Laterosols are dark colored surface soil with lighter subsoil, and, in addition to being slightly acid, contain a high amount of organic matter. Because of their low fertility level, they have limited use for farming. Extensive areas of the northern Andes are represented by Andosols. Such soils consist primarily of volcanic ash with dark surfaces, combined with organic matter and minerals such as nitrogen, phosphorus, calcium and potassium. Those that are not too acid are relatively fertile and excellent for growing different crops. Sectors of the Departamento del Valle, dominated by Andosols, have excellent pasture lands and areas devoted to agriculture.

Dark paramo soils, which may be derived from heavy clays, perhaps of glacial origin are found adjacent to Andosols. They consist of some volcanic ash and are characterized by a high degree of acidity and paucity of nutrients. The paramo lands have high humidity, low temperature, the vegetation is poorly diversified and consists of pastures and forests of secondary growth.

The northern part of the Departamento del Valle is characterized by Reddish Brown Lateritics. These soils contain dark, reddish brown, granular clay surface soil, with yellowish-brown, clay subsoil. Aluminum silicate, its principal mineral compound, is mixed with iron and other ingredients of inorganic and organic origin. They occur below 2000 meters on which are primary and secondary forests in addition to pastures, coffee plantations and other cultivated areas.

## Climate

The complexity of its geography contributes to the variety of climates existing in the Departamento del Valle, since these elements are intimately associated. It is interesting to note that all four of the climatic regions outlined by Eidt (1969) for South America, are represented in the Departamento del Valle, namely, tropical rain, temperate, arid and tundra.

Tropical rain climates are confined to the Pacific territory, from sea level to the mountain bases reaching an elevation of close to 1,000 meters. These areas are hot and humid, with temperature ranges from 24°C to 30°C. The annual rainfall is heavy, exceeding 760 cm a year. It rains almost daily, thus this area does not have a true dry season. Humid warm winds of the Pacific Ocean and Andean chain contribute to the heavy precipitation; Figure 3, adapted from Espinal (1968), illustrates the rainshadow influence. According to Espinal (1968), within the Western and Central Cordillera there are two rainy periods during the year: the first from April to June, and the second from September to November. Between these wet seasons there is notably decreased precipitation.

Temperate climates are characteristic of the subtropical areas extending from 1,000 m to 2,000 m, which have a temperature range of 18°C to 24°C. These areas are the first table lands above the lowlands, and are influenced by higher masses of the Andes and by action of two kinds of winds, interpreted as mountain-valley breezes and land-sea breezes. These winds affect climate and precipitation of the Cauca Valley system, and rivers, and other subtropical areas of this territory.

The eastern part of the Departamento maintains a cooler climate typical of areas above 2,000 meters, (in which various paramos are found). The northern sector of the Central Cordillera contains an arid zone, subjected to strong winds. This zone contrasts with the cloudy and rainy forests dominating the Andean landscape. Some of the higher peaks of Central Cordillera are cool and damp paramos where the temperature is below 12°C.

# SOIL MAP OF THE DEPARTAMENTO DEL VALLE

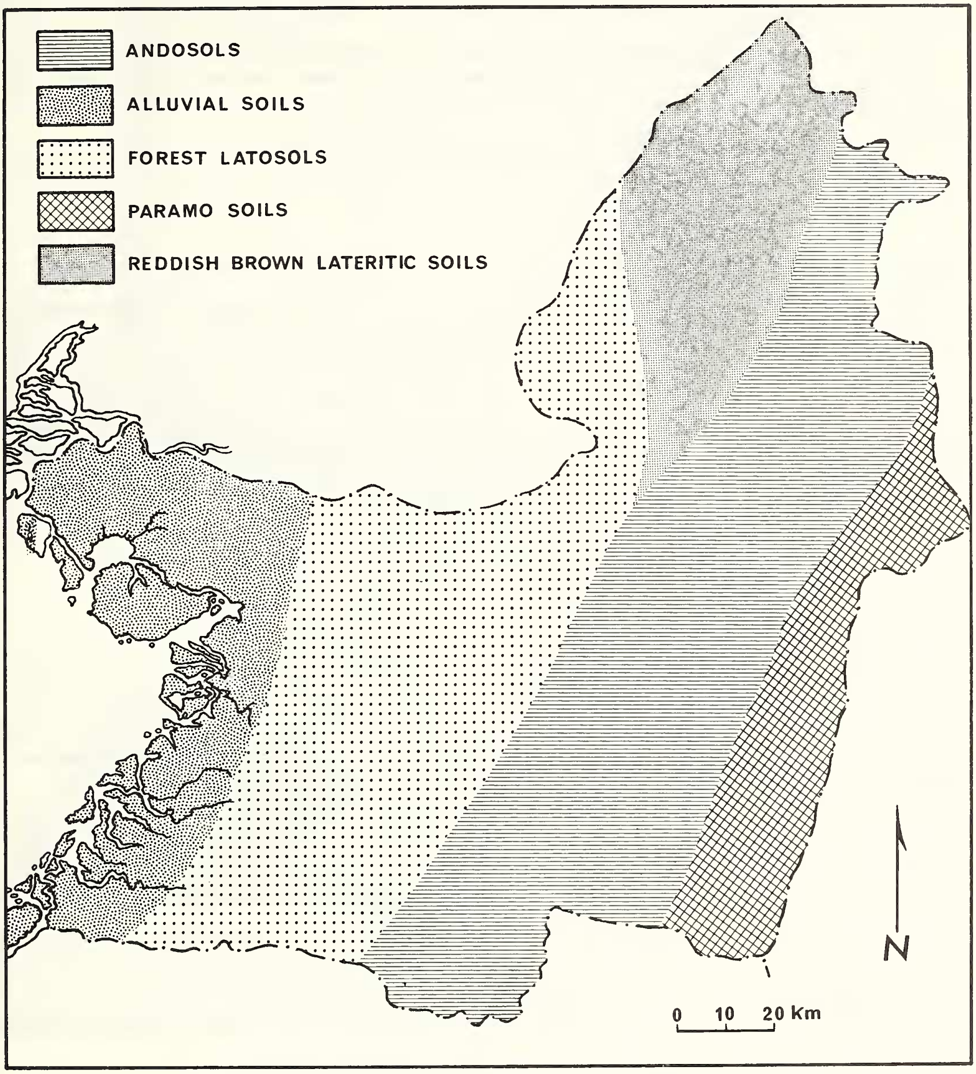


Fig. 3. Soil map of the Departamento del Valle.

## VEGETATIONAL FORMATIONS OF THE DEPARTAMENTO DEL VALLE

Most of the information presented below, including Fig. 4, is based on Espinal (1968), and Espinal and Montenegro (1963). These studies were made according to the classification established by Holdridge (1947), which considers aspects of temperature and humidity in analysis of life zones.

Ecological parameters of rodents and other mammals, as well as of the ectoparasites affecting them are highly dependent on biotic conditions, soils, climates and other factors. Vegetational formations are therefore of primary importance in understanding habitat requirements and distribution patterns of these animals. However, such formations in time and space usually grade into one another and therefore are not permanent. In addition, many animals and plants are able to tolerate a moderate range of climatic conditions.

A brief description of all of the vegetational zones outlined for the Departamento del Valle follows.

### Tropical Very Dry Forest

This formation is in two areas. One is Loboguerrero, at the upper part of Rio Dagua in the center of the Departamento. The other region represents a flat belt of forest platform in the Central Cordillera, extended from Cali to near San Francisco at the left shore of the Cauca River, reaching an elevation of 1200 to 1400 m. The prevalent climate of this zone is dry and the mean temperature is over 24°C. Mean rainfall during the year ranges from 500 to 1000 mm. Characteristic plants of this zone are figs (*Ficus* spp.), *Vachelia farnesiana*, spurge (*Euphorbia caracasana*), *Pithcellobium dulce*, *Desmanthus virgatus*, *Achatocarpus nigricans*, mesquite (*Prosopis juliflora*), *Jatropha gossypiifolia*, *Fugatera pterota*, *Ocimum micranthum*, *Heliotropium* sp., *Lantana canescens*, *Citharexylum* sp., *Portulaca pilosa* and *Talinum paniculatum*.

### Tropical Dry Forest

It is distributed along the Central Valley crossed by the Cauca River and along a strip of land surrounding the Tropical Very Dry Forest of Loboguerrero. Mean temperature of the area is over 24°C and rainfall fluctuates between 1000 and 2000 mm. The characteristic vegetation of this zone grows in lands not over 1000 m high and consists of cabuyas (*Furcraea* sp.), *Croton* sp., *Turnera almifolia*, *Cephalocereus colombianus* and other plants.

### Tropical Moist Forest

This zone occurs in three areas below 1000 m in the upper half of the Departamento. They are the canyon of Rio Garrapatas near El Cairo and Versalles, a strip near Rio Dagua and probably an area in the mid portion of Rio Calima. The mean temperature is higher than 24°C and the mean rainfall is from 2000 to 4000 mm. Some plants found in this type of forest are the balsa (*Ochroma lagopus*), roble (*Tabebuia pentaphylla*), and hogplum (*Spondias mombin*).

### Tropical Very Wet Forest

This formation extends from the basin of Rio Anchicayá as a belt that runs from south to north along the Western Cordillera. The area is dominated by a variety of plants such as ceiba (*Ceiba pentandra*), balsa (*Ochroma lagopus*), black rubber (*Castilla elastica*), guarumos (*Cecropia* spp.), calabash (*Crescentia cujete*), cedars (*Cedrela* spp.), annato (*Bixa orellana*), sandbox (*Hura crepitans*), and others. These lands are not above 1000 m. The temperature exceeds 24°C and there is a mean rainfall of 4000 to 8000 mm per year.

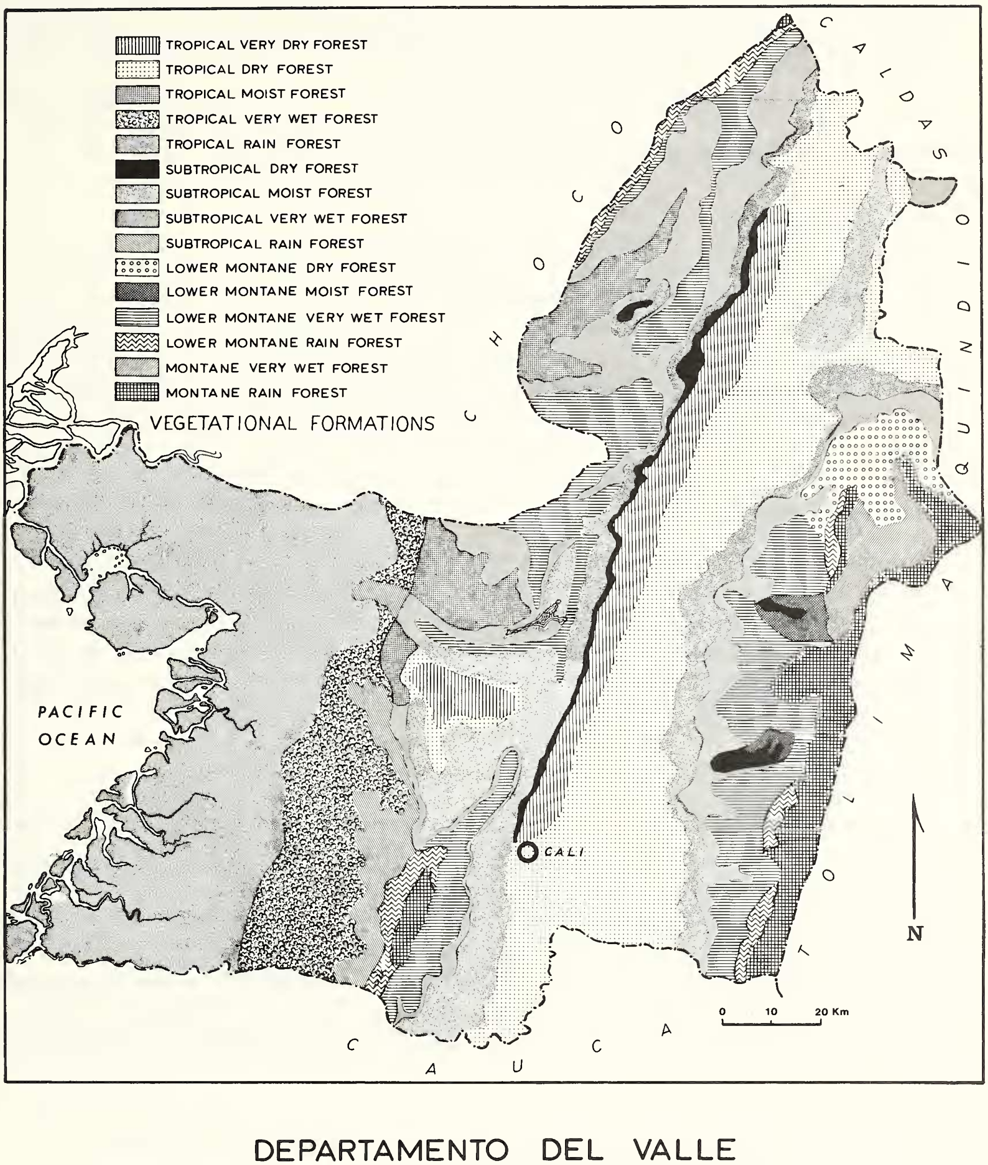


Fig. 4. Vegetational formations of Departamento del Valle.

### Tropical Rain Forest

This is the largest of the vegetational formations of the Departamento, extending from the very wet lowland coast line to the margins of the Western Cordillera. Dense mangrove forests consist primarily of red mangrove (*Rhizophora brevistyla*) in association with black mangrove (*Avicennia marina*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus*). Inland forests, beyond the Pacific littoral, contain a diversity of plants such as guarumo (*Cecropia* sp.),wild figs (*Ficus*), mammagua (*Inophleum armatum*), membrillo (*Gustavia superba*), *Acacia melanoceras*, sensitive-plant (*Mimosa*), cashew (*Anacardium excelsum*), balsa (*Ochroma* spp.), and many others. The tropical rain forests are below 1000 m, in a climate with mean temperature above 24°C and mean annual rainfall exceeding 8000 mm.

### Subtropical Dry Forest

This includes isolated areas on the eastern half of the Departamento. The major area is along the oriental baseline of the Western Cordillera from Cali to San Francisco. One patch is in El Dovio's ravine and two other patches occur in the Central Cordillera. Typical plants in this zone are figs (*Ficus* spp.), fiques (*Fourcraea* sp.), mosquero (*Croton* sp.), big belly tree (*Wigandia caracasana*), indigo (*Indigobera* sp.), cuipo (*Cavanillesia platanifolia*), among others. It registers a mean temperature of 17°C to 24°C and the mean annual rainfall is between 500 to 1000 mm.

### Subtropical Very Humid Forest

This formation encompasses very humid areas of the Western and Central Cordillera having an elevation between 1100 to 1900 m. The mean temperature is from 17°C to 24°C and the annual rainfall fluctuates between 2000 to 4000 m. The vegetation of this zone is represented by guamo (*Inga* spp.), guayacan (*Tabebuia chrysantha*), balsa (*Ochroma lagopus*), guarumo (*Cecropia*), yaragua (*Melinis minultiflora*), pigs fern (*Pteridium aquilinum*), fox tail (*Andropogon* sp.), and others.

### Subtropical Moist Forest

It is distributed as an extensive area surrounding the dry Rio Cauca valley and extending to the edges in the Western and Central cordilleras. Other patches of this zone are located in areas surrounding El Dovio and in the upper portion of the rivers Dagua, El Carmen and El Treinta. The zone reaches an altitude between 1100 to 2000 m. The mean temperature ranges from 17°C to 24°C, while the annual rainfall is between 1000 to 2000 mm. Typical plants of this zone are the macedero (*Trichantera gigantea*), surrumbo (*Trema micrantha*), cordoncillo (*Piper aduncun*), balsa (*Ochroma lagopus*), iraca (*Carludovica palmata*), trompet (*Bocconia frutescens*), coralito (*Hamelia patens*), rubber (*Ficus* sp.), chayote (*Sechium edule*) and many others.

### Subtropical Rain Forest

It is particularly represented by a strip of watered land of the Western Cordillera with elevations between 900 to 1900 m. The humidity in this vegetation formation is very high and the temperature reaches from 17°C to 24°C. The annual rainfall exceeds 4000 mm. This zone combines some virgin forests as well as agriculture lands. Some of its characteristic plants are platanillos (*Heliconia*), ferns (*Gleicheniaceas*), guarumo (*Cecropia*), rubber (*Castilla elastica*), paco (*Cespedesia macrophylla*), pejibaye (*Guilielma gasipals*), and avocado (*Persea americana*).

### Lower Montane Dry Forest

This formation is limited to an area of high elevations (from 2000 to 3000 m) of Barragan in the Central Cordillera. The region possesses a dry climate with a mean temperature of 12°C to 17°C, and an annual rainfall of 500 to 1000 mm. The native vegetation is poor and consists primarily of capers (*Cassia* sp.) and mosqueros (*Croton* sp.); cultivated species include maize (*Zea mays*), onion (*Allium cepa*), wheat (*Triticum*), and potatoes (*Solanum tuberosum*).

### Lower Montane Moist Forest

This region includes two areas in the Central Cordillera, where the altitude is from 1800 to 3000 m. It is a cold formation, humidity is high and mean temperature varies from 12°C to 17°C. Annual rainfall is over 4000 mm. Some of the plants found in this territory are the following: carbonero (*Befaria* sp.), chilco (*Baccharis* sp.), capers (*Cassia* sp.), and mortiño (*Miconia albicans*).

### Lower Montane Very Wet Forest

This formation occupies extensive subtropical lands of the Western and Central Cordillera at elevations between 1800 and 3000 m. The cool climate registers a mean temperature of 12°C to 17°C. Annual precipitation is calculated to be between 2000 to 4000 mm per year. These forests contain many different plants such as guarumos (*Cecropia* spp.), lichens (*Cora pavonia, Cetraria* sp.), mosses (*Polytricum* sp.), horse tail (*Equisetum* sp.), encimo (*Weinmannia balbisiana*), cascarillo (*Ladenbergia*), etc.

### Lower Montane Rain Forest

This is a wet formation distributed as occasional areas in the Western and Central Cordillera. The elevation ranges from 1800 to 2900 m and the mean temperature varies from 12°C to 17°C. The annual rainfall registers over 4000 mm. Typical plants of this zone are the white guarumo (*Cecropia*), capers (*Cassia* sp.), quassia (*Quassia* sp.), cherry (*Freziera sericea*), cedrillo (*Brunellia* sp.), lulo (*Solanum quitoense*), horse tail (*Equisetum bogotense*), berries (*Rubus* sp.), strawberries (*Fragaria* sp.), and others.

### Montane Very Wet Forest

This formation occupies a broad portion of the typical paramo distributed from Santa Lucia to Barragan in the Central Cordillera. It has an elevation above 3000 m and a mean temperature from 6°C to 12°C. The annual rainfall fluctuates between 1000 to 2000 mm. The plant-life is represented by frailejones (*Espeletia*), capers (*Cassia* sp.), espadero (*Rapanea* sp.), charcoal maker (*Befaria* sp.), morteno (*Hesperomeles* sp.), grasses such as *Calamagrotis* and *Festuca*, etc.

### Montane Rain Forest

These areas are very humid, over 3000 m in altitude, localized in the Western and Central Cordillera. Mean temperature is between 6°C and 12°C and rainfall is over 2000 mm. This type of vegetation formation contains cultivated territories as well as undisturbed forests. Among the plants found in these lands are frailejones (*Espeletia* sp.), blackberries (*Rubus* sp.), encenillo (*Weinmannia* sp.), *Senecio* sp., *Vaccinium* sp., cherry-tree (*Prunus* sp.) and *Bacharis* sp.

## HISTORIC AND ZOOGEOGRAPHIC SUMMARY OF THE MAMMALS OF SOUTHWESTERN COLOMBIA

The ecological parameters of mammals and their ectoparasites in Colombia and other South American countries is of interest to investigators concerned with a variety of zoonoses linked to those animals. However, little has been reported on their biology and distribution. Even systematic studies of these vertebrates are not complete and names and taxonomic status of a number of forms are not settled.

To understand the origin and distribution of mammals presently occurring in southwest Colombia one must read an array of discussions by authorities on South American mammals. To fit the limited scope contemplated here, I have tried to be selective in interpretation of possible events that, in my opinion, have a logical foundation. References concerning evolution and zoogeography of South American mammals are Hershkovitz (1962, 1966, 1969, 1972); Keast (1968); Loomis (1914); Patterson and Pascual (1963, 1968); Savage (1974); Scott (1937); Simpson (1940, 1943, 1945, 1950, 1969); Stirton (1950).

The theory of plate tectonics has introduced a new argument for exploring the origin and distribution of Latin American fauna and flora (Raven and Axelrod, 1975; Valentine and Moores, 1974). According to this theory, movement of land masses or plates constituting the earth's crust produces cataclysms and volcanic action with subsequent complicated modifications of the elements involved. As applied to the southern continents, and particularly to South America, some intriguing perspectives occur with regard to the origin and affinities of the biota. In view of the geological facts, during the Middle Cretaceous South America was connected with Africa, and via Antarctica, with Madagascar, India and Australia. It was separated from those eastern lands over an extended period of time. Apparently the connection with Australia lasted longer. It has been speculated on this basis that an exchange of fauna, at least in part by island-hopping, took place between Australia and South America until early Oligocene. On the other hand, a more effective connection between South America and Africa existed until the end of the Cretaceous.

Probably during late Eocene, interchange of tropical and warm-temperate animals between South America and Africa was greater than between Africa and North America. Some groups of animals, such as the river turtles, family Pelomedusidae, which occur in South America, Madagascar and Africa, also seem to afford a logical basis for this assumption. It is also believed that routes for the movement of cool-temperate organisms between southern South America and Australia existed until nearly 4 million years ago. The argument appears to be substantiated by certain elements of the flora of angiosperms common in Africa and South America.

Events of a different nature, primarily geological and climatic, occurring in the millions of years since separation of the southern continents during the Cretaceous, have interrupted faunal development and geographical ranges of taxa in South America. This has introduced many gaps that obscure the entire historical sequence.

Geological changes during the Cenozoic, are very important in attempting to understand some of the general history of the mammals of the Departamento del Valle, and other parts of western Colombia.

The mammalian faunal structure of South American began to evolve with primitive forms recorded from the Paleocene, such as marsupials, members of the orders Condylarthra, Notungulata, Litopterna and other ungulates (Hershkovitz, 1968; Patterson and Pascual, 1968; Simpson, 1950).

Apparently during the beginning of the Tertiary, the Middle American bridge permitted mammals to move to and from North and South America. The many fossil discoveries from

southern South America have revealed that, early in the Paleocene, the most important nuclei of South American mammals were concentrated in this portion of the continent. The earliest mammal records from northern South America and Middle America are represented only by marsupials and condylarths.

During the Eocene and Oligocene epochs, and presumably during most of Cenozoic, North America was isolated from South America by a sea barrier since the connection represented at present by the Isthmian link did not exist. Fossils of monkeys and caviomorph rodents have been found in Oligocene beds of South America. However, the evolution and dispersal of these mammals prior to this time remain a mystery. Hershkovitz (1968) and Simpson (1943, 1950) believe that these mammals invaded South America probably as island-hoppers in the early Oligocene. According to Raven and Axelrod (1975), it is more probable that primates and caviomorph rodents reached South America and Africa during the Oligocene. It is also probable that the ancestors of those mammals arrived in this Southern continent during the Cretaceous. However, fossils from this epoch that would support this theory have not been found in South America.

From the fossil history, it is evident that armadillos, ant-eaters and ground sloths inhabited South America since the Tertiary and were probably distributed in areas of mild climate, at least close to our present tropical conditions. It is possible that they originated from a Cretaceous stock. According to Simpson and other authors, they gradually moved into South America when the Middle American land bridge was re-established in the late Pliocene. There is no indication that these mammals migrated between South and North America before this time, with the probable exception of the ancient armadillos. Fossil armadillos have been discovered in early Tertiary beds of North America (Kürten, 1969). Hershkovitz (1972) discussed the probability that migration of terrestrial animals started during the period of isolation of the continents. Other authors (Scott, 1937; Simpson, 1940, among them) maintain that during the period of isolation of the continents, the South American rodent fauna was apparently represented only by caviomorphs. They also believe that the North American fauna then contained myomorph and sciuromorph rodents, but no caviomorphs. According to Hershkovitz (1972) the tribe Sigmodontini, of the murid subfamily Cricetinae, distinguished by the possession of a complicated glans penis with a three digitated baculum, originated in this continent from ancestors that rafted there from Africa. From South America they subsequently spread northward into North America and Eurasia. On the other hand, the Peromyscini, characterized by a simple glans penis, with an unbranched and normally elongated baculum, is essentially North American and apparently replaced the Sigmodontini, when they probably disappeared from boreal America during Oligocene. The complex-penis type Cricetinae seem to have more recently invaded Central and North America. This hypothesis appears to be supported by some ectoparasites, such as fleas, occurring on these mammals. The flea genus *Polygenis*, which has moved into Middle America with its complex-penis type Cricetinae and Caviomorph hosts from South America, is a good indicator of such an event (Wenzel and Tipton, 1966).

In South America, as well as in other areas of the world, the early history of bats is obscure because of the paucity of fossils. However, it is estimated that they probably appeared in this continent after the Paleocene (Patterson and Pascual, 1972). Hershkovitz (1969) believes that bats were probably well established in north-western South America and the Isthmian region during most of the Tertiary. Storms may have played an important role in interchange of bats between the Americas when they were separated.

During Pleistocene times, South America received from North America a diversity of mammals such as horses, mastodonts, tapirs, peccaries, camels, deer, some cricetine rodents, squirrels, rabbits, canids, bears and other carnivores. Faunal interchange between North and South

America during the late Tertiary, as well as radiation of many mammal groups has been the subject of much speculation and even today no causal explanation is generally accepted. However, it appears that the majority of the families and genera of South American mammals originated on this continent when it was completely or partially isolated.

At the present time the northern sector of South America contains the major portion of the mammalian fauna, while the southern sector is exceedingly poor in number of species (Fittkau, 1969; Osgood, 1942). Information based on Baker (1967), Cabrera and Yepes (1940) and other authors, as well as on personal data, reveals that the major portion of southwestern Colombia, corresponding to Pacific Coastal Lowlands, maintains a number of ubiquitious mammal species in addition to those forms possessing a more restricted distribution. The remaining mammalian fauna of the southwest region of Colombia is fundamentally represented by a limited number of Andean elements.

The recent biogeographical approach for the Neotropical region presented by Müller (1973) is followed for the brief zoogeographic description of mammals of the Departamento del Valle and the rest of southwestern Colombia. Müller based his interpretation of zoogeographical patterns on dispersal centers devised from comparative studies of plant and animal distribution.

Colombia and several other territories of tropical America belong to the Brazilian Subregion of the Neutropical Region (Hershkovitz, 1958). The complexity of ecological situations in this nation has provided for the existence of a diverse mammalian fauna. Many areas, particularly those humid zones rich in vegetation and not yet disturbed by man, offer optimal condition for some populations of mammals, especially rodents and bats. They possess good reproductive potential and have been able to occupy a number of ecological niches through the development of specialized features. Those lands characterized by drier conditions and a low productivity of plants, particularly of fruit trees, as well as those somewhat disturbed by man, show, as a rule, less diversity and smaller populations of mammals. In a broad sense, sylvan species are not too selective in their food and habitat requirements, while pastoral species seem to display a higher level of adaptation by their food habits and locomotor organs.

Among the Neotropical dispersal centers outlined by Müller, the following directly concern the Departamento del Valle and other major portions of southwestern Colombia: 1. the Cauca Center, 2. The Colombian Montane Forest Center, 3. The Colombian Pacific Center, and 4. The North Andean Center. For this discussion it is convenient to follow these zoogeographic divisions. Figure 5 has been prepared using as a source the map given by Müller (1973).

*The Cauca Center.* – As defined by Müller, this zone is represented by the Cauca and Patia valleys, between the west and central Cordilleras of Northern Colombia, and are separated from each other by the Popayan plateau at an elevation of 1750 meters. Like many other areas of Colombia, this territory is being progressively deforested; however, it still harbors many mammalian species, some of which are widely distributed in other areas of the Continent. Some of the faunal elements that previously existed in this territory probably disappeared many years ago. Faunal indicators of this zone are the wooly opossum, *Caluromys derbianus derbianus*, and red squirrel, *Sciurus granatensis valdiviae*, which are found in the Cauca and Patia valleys. The ancestors of these mammals evidently came from the north. According to Müller, the slight differentiation between the populations of these subspecies in the two valleys suggests that the Popayan plateau is not a strong barrier to species adapted to open habitats. In addition, the forest biome of the southern part of the Cauca Valley did not prevent a spread of fauna during post-glacial times.

Available information indicates that South America experienced drastic climatic changes during the Quaternary (Hammen, 1961; Patterson and Pascual, 1963; Vanzolini, 1973). Haffer (1967) considers that climatic changes during the Pleistocene and post-Pleistocene had more influence than orogenic events on the fauna west of the Andes. He also states that isolation

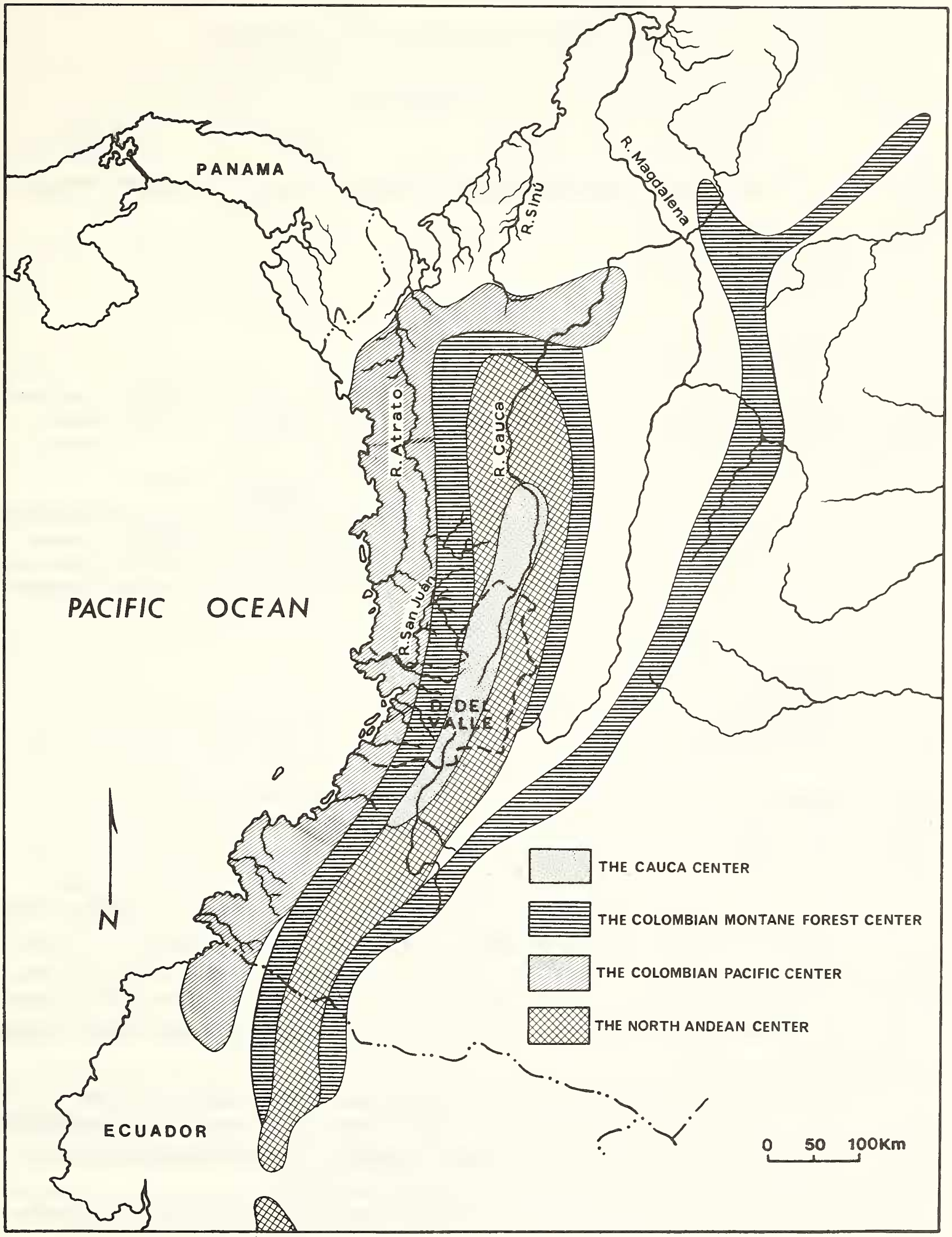


Fig. 5. Dispersal Centers related to the southwest Colombian fauna.

and differentiation of most Pacific species occurred after the early Pleistocene uplift of the Northern Andes, probably under orographic conditions similar to those existing today.

Ecological relationships of mammal species inhabiting this area are indicated in Table 1.

Table 1. Ecological Relationships of Some Mammals of the Cauca Center

| HABITAT | LIVING SPACE: Surface or subsurface | Aquatic or semiaquatic | Roosting areas | Arboreal or semiarboreal |
|---|---|---|---|---|
| Meadow | *Zygodontomys brevicauda brunneus* | | | |
| | *Sigmodon hispidus bogotensis* | | | |
| | *Sylvilagus brasiliensis fulvescens* | | | |
| | *Urocyon cinereoargenteus* | | | |
| | *Odocoileus virginianus* | | | |
| Forest: open or close canopy | *Oryzomys alfaroi palmirae* | *Chironectes minimus* | *Artibeus jamaicensis* | *Didelphis m. marsupialis* |
| | *Oryzomys munchiquensis* | *Lutra annectens* | *Artibeus lituratus* | *Philander opossum griscescens* |
| | *Oryzomys albigularis* | | *Peropteryx kappleri kappleri* | |
| | *Thomasomys aureus* | | *Noctilio labialis* | *Marmosa impavida caucae* |
| | *Thomasomys fuscatus* | | *Glossophaga soricina* | *Rhipidomys latimanus* |
| | *Dasyprocta punctata* | | *Tadarida brasiliensis* | *Reithrodontomys mexicanus* |
| | *Agouti paca guanta* | | *Lasiurus ega fuscatus* | *Potos flavus megalotus* |
| | *Dasypus novemcinctus* | | | |
| | *Nasua nasua candace* | | | |
| | *Conepatus semistriatus* | | | |
| | *Mustela frenata* | | | |
| | *Felis yagouaroundi* | | | |
| | *Felis tigrina pardinoides* | | | |
| | *Mazama americana zetti* | | | |
| Domestic or semi-domestic | *Rattus rattus* | | *Molossus major* | |
| | *Rattus norvegicus* | | *Eumops bonariensis* | |
| | *Mus musculus* | | | |

*The Colombian Montane Forest Center.* – This dispersal center seems to be confined to the forest biomes of Colombia (with the exception of the Sierra Nevada de Santa Marta), Ecuador and Venezuela. It includes two subcenters, namely, the West Andean and the East Andean. Inasmuch as affinities have been found between the animal populations of the Central Andes and those of the West Andean Subcenter, the Central Andes is included with the West Andean Subcenter (Müller, 1973).

The fauna of the Colombian Montane Forest Center may be considered subtropical and displays similarities with those of the Colombian Pacific Center, which is essentially tropical. This condition results from most of the species of the Colombian Montane Forest Center having evolved originally from ancestors that came from the lower lands.

Characteristic mammals of the Colombian Montane Forest Center and their ecological relationships are indicated in Table 2.

Table 2. Ecological Relationships of Some Mammals of the Colombian Montane Forest Center

| HABITAT | LIVING SPACE | | | |
| --- | --- | --- | --- | --- |
| | Surface or subsurface | Aquatic or semiaquatic | Roosting areas | Arboreal or semiarboreal |
| Forest: open or close canopy | *Cryptotis thomasi medallinius* | *Chironectes minimus* | *Eptesicus brasiliensis andinus* | *Didelphis azarae* |
| | *Oryzomys caliginosus monticola* | *Ichthyomys hydrobates nicefori* | *Myotis chiloensis* | *Metachirus nudicaudatus colombianus* |
| | *Nectomys alfari esmeraldarum* | | | *Philander opossum griscescens* |
| | *Thomasomys aureus popayanus* | | | *Sciurus pucherani caucensis* |
| | *Thomasomys cinereiventer* | | | *Reithrodontomys mexicanus milleri* |
| | *Chylomys instans* | | | |
| | *Dasyprocta fuliginosa candelensis* | | | *Echinoprocta rufescens* |
| | | | | *Aotus trivirgatus lemurinus* |
| | *Sylvilagus brasiliensis fulvescens* | | | |
| | *Nasua olivacea* | | | |
| | *Mazama americana* | | | |
| Domestic or semi-domestic | *Rattus rattus* | | | |
| | *Rattus norvegicus* | | | |
| | *Mus musculus* | | | |

*The Colombian Pacific Center.* – The extensive territory of lowlands in the western part of Colombia involves the major portion of the center. This territory continues to the north along the base of the mountains and ends on lands watered by the Magdalena River. To the south, this center encroaches upon a portion of the northern part of Ecuador. This center includes two subcenters: the Nechi, which encompasses the area between the Rio Sinu and the lower reaches of the Rio Cauca; and the Chocó, which includes the area west of the Andes.

Possibly during the Tertiary, the gap separating Central and South America divided the territory now known as the Colombian Pacific Center. This thesis stems from the existence at that time, of a seaway south of Panama and the Gulf of Uraba, which connected the Caribbean Sea and the Pacific Chocó basin of Western Colombia (Haffer, 1967). This seaway was closed during the late Pliocene and seems to correspond to the Bolivar Geosyncline discussed by Nygren (1950) and Hershkovitz (1968).

Glacial and interglacial periods of the Pleistocene evidently influenced the Pacific lowlands of Colombia. Glaciation of the mountains produced considerable temperature reduction and high humidity. At this time, sea level lowered about 100 m and extensive movements of fauna occurred between the Amazonian region and the trans-Andean area of western Colombia and Central America. The interglacial periods were particularly drier in the northern part of Colombia, when the humid forest moved southward due to influence of winds, and sea level rose about 30 to 50 m. As a result of this condition the Maracaibo basin and other parts of the Northern Colombian plains were flooded (Haffer, 1967).

Studies of birds, lizards and amphibians presently inhabiting this center, have indicated the origin and distribution patterns of some of these vertebrates. A strong relationship of the Pacific lowland fauna of Colombia to that of the Amazon region suggests the interchange of animals during remote times of the Pleistocene. Today, the Pacific mammalian fauna of the

Departamentos del Valle, Chocó, Cauca and Nariño, inhabiting dense forests of the coastal lands, are, with some exceptions, similar to those of the Pacific lands of Eastern Panama and Northern Ecuador.

Some elements of the mammal fauna of the Colombian Pacific Center and their ecological relationships are indicated in Table 3.

Table 3. Ecological Relationships of Some Mammals of the Colombian Pacific Center

| HABITAT | LIVING SPACE | | | |
|---|---|---|---|---|
| | Surface or subsurface | Aquatic or semiaquatic | Roosting areas | Arboreal or semiarboreal |
| Marsh | *Procyon cancrivorus panamensis* | *Hydrochaeris hydrochaeris isthmius* | | |
| | *Nectomys alfari esmeraldarum* | | | |
| Meadow | *Zygodontomys brevicauda* | | | |
| | *Sigmodon hispidus* | | | |
| | *Odocoileus virginianus tropicalis* | | | |
| Forest: open or close canopy | *Oryzomys capito* | *Chironectes minimus* | *Carollia subrufa* | *Didelphis marsupialis* |
| | *Oryzomys caliginosus* | *Hydrochaeris hydrochaeris isthmius* | *Carollia castanea* | *Caluromys d. derbianus* |
| | *Neacomys tenuipes tenuipes* | | *Chiroderma villosum* | *Philander opossum melanurus* |
| | | *Lutra annectes* | | |
| | *Heteromys australis* | | *Phyllostomus hastatus* | |
| | *Proechimys guyannensis colombianus* | | *Phyllostomus discolor* | *Marmosa robinsoni isthmica* |
| | *Proechimys semispinosus* | | *Sturnira lilium* | *Cebus capucinus* |
| | *Hoplomys gymnurus* | | *Uroderma b. bilobatum* | |
| | *Dasyprocta punctata chocoensis* | | *Glossophaga soricina* | *Ateles fusciceps* |
| | | | *Artibeus cincereus* | *Tamandua tetradactyla* |
| | *Agouti paca* | | *Vampyrops helleri* | *Cyclopes didactylus* |
| | *Nasua nasua* | | *Vampyrops dorsalis* | *Bradypus griseus* |
| | *Mustela frenata* | | *Diaemus youngi* | *Choloepus hoffmanni* |
| | *Eira barbara* | | *Desmodus rotundus* | *Oryzomys concolor* |
| | *Galictis vittata canaster* | | | *Tylomys mirae* |
| | *Felis yagouaroundi* | | | *Dyplomys caniceps* |
| | *Felis pardalis* | | | *Microsciurus flaviventer isthmius* |
| | *Felis onca* | | | *Bassaricyon gabbi medius* |
| | *Tayassu pecari* | | | *Potos flavus* |
| | *Tayassu tajacu* | | | |
| | *Mazama americana* | | | |
| | *Tapirus bairdii* | | | |
| Domestic or semi-domestic | *Rattus rattus* | | *Molossus major* | |
| | *Rattus norvegicus* | | *Eumops auripendulus* | |
| | *Mus musculus* | | | |

*The North Andean Center.* – This area is the Central and Eastern Cordillera in Colombia and the Andean mountains in Ecuador and Peru. The most characteristic biome of this center is the paramos with its selected plant and animal life. To this center belong such mammals as whose names and ecological relationships are indicated in Table 4.

According to Müller, it is apparent that 28 species of the North Andean faunal elements (more than 75%) belong to families of North and Central American origin.

Chapman (1917), referring to birds from the paramo zone, indicated that the majority were

derived from the sea level equivalent of this zone in southern South America. It seems logical to assume that the same circumstance occurred with the mammals also.

Table 4. Ecological Relationships of Some Mammals of the North Andean Center

| HABITAT | LIVING SPACE | | | |
|---|---|---|---|---|
| | Surface or subsurface | Aquatic or semiaquatic | Roosting areas | Arboreal or semiarboreal |
| Meadow | *Sylvilagus brasiliensis andinus*<br>*Cerdocyon thous*<br>*Odocoileus virginianus goudotii* | | | |
| Forest: open or close canopy | *Caenolestes obscurus*<br>*Thomasomys cinereiventer cinereiventer*<br>*Tremarctos ornatus*<br>*Felis concolor*<br>*Mazama americana*<br>*Pudu mephistophiles*<br>*Tapirus pinchaque* | | *Myotis* sp.<br>*Lasiurus* sp. | *Marmosa dryas* |

## FLEAS OF SOUTHWESTERN COLOMBIA

In this presentation descriptions are limited to those forms that are either new to science or have been previously described from one sex. Only citation of the original description for every taxon is given. For complete synonymy, type data and other distributional records the reader is referred to Johnson (1957), Tipton and Méndez (1966) and Tipton and Machado-Allison (1972). The principal sources of information of Colombian mammal hosts have been Allen (1912, 1913, 1915, 1916), Borrero (1967), Cabrera (1958 and 1961), Cabrera and Yepes (1940), Hershkovitz (1941, 1947, 1948, 1949, 1960, 1962), Gyldenstolpe (1932), Tate (1932a, b, 1935), and Osgood (1912).

The following report pertains to taxa from southwestern Colombia available to us for study and forms that are not represented in our material but have been reported before from that territory or are likely to occur there. The order followed is that of Johnson (1957).

To conserve space, I have abbreviated locality data for material of previously described species by omitting collection number, name(s) of collector(s), and designating only month of collection by Roman numeral. These details are available on request. For new species described here, complete data are given for each specimen. The acronym "HTC" preceding a number in parentheses represents Harold Trapido Collection. Other numbers in parentheses refer to material in the collection of the Gorgas Memorial Laboratory.

## KEY TO SPECIES OF FLEAS OF SOUTHWESTERN COLOMBIA[3]

1 Thorax very reduced or compressed; antesensilial bristles absent; female burrowed into skin .......................................... 2

1′ Thorax not reduced or compressed; antesensilial bristles present; females not burrowed into skin .......................................... 3

3. The following papers were helpful in the preparation of this key: Johnson (1954 and 1957), Ewing (1929), and Tipton and Méndez (1966). *Rhopalopsyllus lugubris, R. cacicus saevus, Polygenis dunni,* and *P. roberti beebei* have not been reported from southwestern Colombia; however, they are likely to occur there and are included in this key.

2 ( 1 ) Head frons angular (Fig. 44); anterior lower margin of hind coxa with tooth-like projection; host not bat ..... *Tunga penetrans* (Linnaeus), p. 165

2′ Head frons rounded; hind coxa without tooth-like projection; host-bat .. ................................ *Rhynchopsyllus pulex* Haller, p. 164

3 ( 1′) Sword-like ridge of mesocoxa absent; mesonotum always lacking pseudosetae; metanotum rectangular, not markedly broader dorsally than ventrally; not more than one row of bristles on abdominal terga II-VI; metacoxa with patch of spinelets on inside ................................ 4

3′ Sword-like ridge of mesocoxa present in most specimens; mesonotum with or without pseudosetae; metanotum much broader dorsally than ventrally; metacoxa without patch of spinelets on inside........................ 7

4 ( 3 ) Genal and pronotal comb present (Fig. 41) ...................... ................................ *Ctenocephalides felis* (Bouché), p. 164

4′ Genal and pronotal comb absent ................................ 5

5 ( 4′) Mesothoracic pleural rod present; tergum VIII of female complete dorsally; bulga of spermatheca (Fig. 40E) not globular, heavily pigmented .. .......................... *Xenopsylla cheopis* (Rothschild), p. 158

5′ Mesothoracic pleural rod absent; tergum VIII of female divided dorsally; bulga of spermatheca globular, lightly pigmented .................. 6

6 ( 5′) Dorsal aedeagal sclerite broad throughout; crochets small and elongate, rodlike; sternum VII of most females with 7-9 bristles............... .................................... *Pulex simulans* Baker, p. 164

6′ Dorsal aedeagal sclerite relatively long and slender; crochets expanded apically, not rodlike; sternum VII of most females with 4-5 bristles .... .................................... *Pulex irritans* Linnaeus, p. 164

7 ( 3′) Head with true helmet (Fig. 11A, 119A); ctenidia on helmet, gena and pronotum............................................... 8

7′ Head without helmet (Fig. 16A); ctenidia absent or present, limited to gena and/or pronotum ........................................ 12

8 ( 7 ) Helmet separated from head dorsally; vertical comb posteromarginal .... 9

8′ Helmet not separated from rest of head (Fig. 11A); vertical comb mesad . ................................ *Cleopsylla monticola* Smit , p. 124

9 ( 8 ) Two large genal bristles anterior to cibarial pump; tergum VIII of male with apodeme; female spermatheca barrel-shaped, without internal tubercle, and hilla not enlarged basally ................................ 10

9′ One or two large genal bristles posterior to or vertically in line with cibarial pump; tergum VIII of male without apodeme; female spermatheca not barrel-shaped, with internal tubercle or with hilla enlarged basally .. 11

10 ( 9 ) Genal comb teeth reduced, slightly longer than broad (Fig. 119A) ...... ................................ *Plocopsylla phyllisae* Smit , p. 127

10′ Genal comb teeth normal, more than twice as long as broad (Fig. 14).... ................................ *Plocopsylla thor* Johnson, p. 127

11 ( 9′) Pronotal comb spines about 18, not pointed (Fig. 12A); male with vertical row of four close-set spiniforms on sternum VII; female with subcaudal row of heavy spiniform setae on sternum IX (Fig. 12A) ...... .......................... *Sphinctopsylla diomedes* Johnson, p. 124

11′ Pronotal comb spines about 30, pointed; male only with normal bristles on sternum VII; female without subcaudal row of heavy spiniform setae on sternum IX ................. *Sphinctopsylla tolmera* (Jordan), p. 127

12 ( 7′) Anterior margin of head conical, with two short spiniform bristles (Fig. 16A); tibia with dorsal comb of short, stout bristles . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Leptopsylla segnis* (Schönherr), p. 131

12′ Anterior margin of head not conical, without short spiniform bristles; tibia without dorsal comb of short, stout bristles . . . . . . . . . . . . . . . . . . . . 13

13 (12′) Several abdominal terga with well developed combs . . . . . . . . . . . . . . . . 14

13′ Abdominal terga without combs . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 15

14 (13 ) Crochets with convex margin dorsad; female sternum VII with caudal margin truncate . . . . . . . . . . . . . . . . . . . . *Ctenidiosomus rex* Johnson, p. 121

14′ Crochets with convex margin ventrad; female sternum VII with caudal margin not truncate . . . . . . . . . . . . . . . *Ctenidiosomus traubi* Johnson, p. 121

15 (14′) Anteroventral margin head with two large genal spines (Fig. 15A); on bats . . . . . . . . . . . . . . . . . . . . *Sternopsylla distincta speciosa* Johnson, p. 127

15′ Anteroventral margin of head with more than two or without genal spines; not on bats . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 16

16 (15′) With combination of: anterior tentorial arm present, inserted anterior to eyes; mesopleural rod not dorsally bifurcated; ventral margin of pronotum not bilobed; tarsal segment V with four pairs of plantar bristles . . . . . . . . 17

16′ Combination not as above . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 31

17 (16 ) Antennal club symmetrical; without apical spinelets on metanotum . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Tetrapsyllus comis* Jordan, p. 132

17′ Antennal club asymmetrical; apical spinelets on metanotum . . . . . . . . . . 18

18 (17′) Frontoclypeal margin of head subconical; pronotal comb present (Fig. 36A) . . . . . . . . . . . . . . . . . . .*Scolopsyllus colombianus* Méndez, p. 142

18′ Frontoclypeal margin of head rounded; pronotal comb absent . . . . . . . . 19

19 (18′) Prosternosome projected downward between coxae, mesocoxa rectangular, margins parallel . . . . . . . . . . . . . . . . . *Rhopalopsyllus* . . . . . . . . . . . . 20

19′ Prosternosome not projected downward between coxae; mesocoxa asymmetrical, obviously broadest basally. . . . . . . *Polygenis*[4] . . . . . . . . . . . . 22

20 (19 ) Spiracle of metepimere oblong, prolonged dorsally; bulga of spermatheca globular (Fig. 39D) . . *Rhopalopsyllus lugubris* Jordan and Rothschild, p. 158

20′ Spiracle of metepimere rounded or ovoid; bulga not globular . . . . . . . . . . 21

21 (20′) Labial palpus extended to apex of coxa I or beyond (Fig. 38A); movable process of clasper longer than distal arm of sternum IX (Fig. 38B); spermatheca somewhat boomerang-shaped (Fig. 38C) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .*Rhopalopsyllus cacicus saevus* Jordan and Rothschild, p. 158

21′ Labial palpus not extended to apex of coxa I (Fig. 37A); movable process of clasper about as long as distal arm of sternum IX (Fig. 37B). Spermatheca strongly S-shaped (Fig. 37C) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Rhopalopsyllus australis tupinus* Jordan and Rothschild, p. 142

22 (19′) Distal arm of sternum IX much shorter than proximal arm; heel of sternum IX strongly angular; inner tube of aedeagus reflexed dorsally, not coiled apically . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 23

22′ Distal arm of sternum IX about equal to length of, or longer than, proximal arm; heel of sternum IX weakly angular; inner tube of aedeagus reflexed ventrally, coiled apically . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 24

23 (22 ) Clypeal tubercle above eye level (Fig. 32A); posterior margin of fixed process convex; spermatheca sinuate, without separation between bulga and hilla (Fig. 32E) . . . . . . . . . . . . . . . . *Polygenis thurmani* Johnson, p. 141

4. Females of *Polygenis* are difficult to identify and the characters used in this key pertain almost entirely to males. The females of *P. trapidoi*, n. sp. and *P. hopkinsi*, n. sp., are unknown.

23′ Clypeal tubercle at eye level (Fig. 29A); posterior margin of fixed process sinuate; spermatheca humped, with distinct separation between bulga and hilla (Fig. 29C) . . . . . . . . . . . . . . *Polygenis klagesi* (Rothschild), p. 140

24 (22′) Distolateral lobes of aedeagus with angular projection; sternum VIII of male divided in half ventrally, with short dorsocaudal extension . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Polygenis trapidoi*, new species, p. 141

24′ Distolateral lobes of aedeagus without angular projection; sternum VIII of male not divided in half ventrally, without dorsocaudal extension . . . . . . 25

25 (24′) Apex of distal arm of male sternum IX with distinct group of stout bristles . . . . . . . . . . . . . . . . . . . . . . . . *Polygenis bohlsi bohlsi* (Wagner), p. 132

25′ Apex of distal arm of male sternum IX without distinct group of stout bristles . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 26

26 (25′) Aedeagal fender present; dorsal margin of fixed process of clasper sinuate; spermatheca with cribose bulga, its ventral margin interrupted at bulga-hilla junction (with probable exception of *P. hopkinsi*, n. sp.) . . 27

26′ Aedeagal fender absent (Fig. 30C); dorsal margin of fixed process of clasper usually slightly convex; spermatheca not cribose, its ventral margin continuous at bulga-hilla junction (Fig. 30E) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Polygenis pradoi* (Wagner), p. 140

27 (26 ) Aedeagal side piece above basal part of inner tube; aedeagal ribs not numerous (Fig. 25B) . . . . . . . . . . . *Polygenis delpontei*, new species, p. 138

27′ Aedeagal side piece absent or below basal part of inner tube; aedeagal ribs very numerous . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 28

28 (27′) Aedeagal lateral lobes very reticulate; subapical ridge of median dorsal lobes of aedeagus present (Fig. 21C) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Polygenis caucensis*, new species, p. 137

28′ Aedeagal lateral lobes not reticulate or faintly reticulate; subapical ridge of median dorsal lobes of aedeagus absent . . . . . . . . . . . . . . . . . . . . . . . 29

29 (28′) Labial palpus extended to trochanter I (Fig. 26A); several distal arm bristles of sternum IX very long, approximately four times maximum width of distal arm (Fig. 26B) . . . *Polygenis dunni* (Jordan and Rothschild), p. 139

29′ Labial palpus not extended to trochanter I; distal arm bristles of sternum IX short or as moderate length, not very long . . . . . . . . . . . . . . . . . . . . . 30

30 (29′) Aedeagal fender well developed, half-moon shaped; distal arm of sternum IX distinctly broad medially (Fig. 31B) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Polygenis roberti beebei* (I. Fox), p. 140

30′ Aedeagal fender reduced to slender, arched, inconspicuous structure; distal arm of sternum IX not distinctly broad medially (Fig. 27C) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Polygenis hopkinsi*, new species, p. 139

31 (16′) Genal comb present . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 32

31′ Genal comb absent . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 33

32 (31 ) First spine of genal comb almost overlapped by second (Fig. 8A); trabecula centralis present; labial palpus 5-segmented; both sexes with three antesensilial bristles. . . . *Neotyphloceras rosenbergi* (Rothschild), p. 117

32′ First spine of genal comb not overlapped by second (Fig. 9A); trabecula centralis absent; labial palpus 4-segmented; both sexes with two antesensilial bristles . . . . . . . . . . . . . . *Adoratopsylla intermedia copha* Jordan, p. 117

33 (31′) Pronotal comb with more than 24 spines; bristles of antennal segment 2 long in both sexes (Fig. 17A) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Dasypsyllus gallinulae perpinnatus* (Baker), p. 131

33′ Pronotal comb of most specimens with less than 24 spines; bristles of antennal segment 2 short in male, not extended to apex of club in female . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 34

34 (33′) Protibia with seven dorsal notches with paired bristles; meso- and metatibia with six dorsal notches with paired bristles proximal to only single dorsal bristle . . . . . . . . . . . . . . . . . . . . . . *Pleochaetis smiti* Johnson, p. 131

34′ Protibia with five or six dorsal notches with paired bristles; meso- and metatibia with five dorsal notches with paired bristles proximal to only single dorsal bristle . . . . . . . *Pleochaetis equatoris equatoris* (Jordan), p. 131

## SUPERFAMILY CERATOPHYLLOIDEA
### FAMILY HYSTRICHOPSYLLIDAE
#### SUBFAMILY CTENOPHTALMINAE
##### TRIBE NEOTYPHLOCERATINI

*Neotyphloceras rosenbergi* (Rothschild)
(Figure 8)

*Typhloceras rosenbergi* Rothschild, 1904, Novit. Zool., 11: 639, Pl. 13, Fig. 68-69; Pl. 14, Fig. 71, 74.

*Material examined.* — *Ex Didelphis marsupialis.* Depto. del Valle, Municipio de Cali – 2♂, Pichindé, 1600m, VIII.

*Ex Didelphis azarae.* Depto. del Valle – ♂, Finca Holanda (nr. Páramo de Chinche), 2700m, X.

*Ex Oryzomys caliginosus.* Depto. del Valle, Municipio de Cali – 3♂, 4♀ Quebrada Honda, nr. Pichindé, 1800m, I, III, VIII, IX.

*Ex Oryzomys alfaroi.* Depto. del Valle, Municipio de Cali – 2♀ Quebrada Honda, nr. Pichindé, 1800 m, III, IX; ♀, Florida, 8 km. S.E. "La Diana", 1700m., X.

*Ex Oryzomys albigularis.* Depto. del Valle, Municipio de Cali – 4♂, 4♀, Valle del Río Pichindé, 1700 - 1900 m., I, X, XII; 2♂, Cerro Munchique, 60 km. by road W. Popayán, Peña del Perro, 2160m., V; ♀, Finca La Flora, Quebrada Norte, Pichindé, 1900m., VIII; 5♂, Saladito, Km. 12, 2000m., III; 4♂, 5♀, Finca Holanda (nr. Páramo de Chinche), 2700 m., X. Depto. del Cauca – ♀, Cerro Munchique, Finca El Retiro, 2200m., V.

*Ex Oryzomys (Oligoryzomys)* species. Depto. del Valle, Municipio del Cali – ♀, Quebrada Honda, nr. Pichindé, 1800m., X.

*Ex Rhipidomys latimanus.* Depto. del Valle, Municipio de Cali – ♀, Quebrada Honda, nr. Pichindé, 1800m., X; ♂, 2♀, Valle del Río Pichindé, 1700 - 1900 m., VII, XII.

*Ex Rhipidomys similis.* Depto. del Cauca – ♀, Cerro Munchique (60 km. by road W. Popayán, sitio No. 1), 2000m., V.

*Ex Thomasomys aureus.* Depto. del Cauca – ♀, Pilimbala, 3100m., V.

*Ex Thomasomys cineriventer.* Depto. del Cauca, Cerro Munchique – ♀, 60 km. by road W. Popayán, Sitio. No. 1, 2500m., V; ♂, sitto No. 3, V; ♂, 60 km. by road W. Popayán, Peña del Perro, 2160 m., V. Depto. del Nariño – 6♂, ♀, Laguna de La Cocha, 2700 m., V; ♂, Km 38, between Pasto & Sibundoy, Comisario de Putumayo, 3100 m., V; ♂, Km. 33, between Pasto & Sibundoy, 2900 m., V.

*Ex Thomasomys fuscatus.* Depto. del Valle, Municipio de Cali – 3♂, Valle del Río Pichindé, 1700 - 1900 m., I, III, XI; 2♂, 2♀, Pichindé, 1900 m., V; 2♂, ♀, Pichindé, Rincón del Yarumal, V; ♂, Pichindé, Finca La Flora, VII; 6♂, 8 ♀, Saladito, Km. 12, 2000 m., II. Depto. del Nariño – ♀, Laguna de La Cocha, 2700 m.

*Remarks.* — In addition to Colombia, this species is distributed in Venezuela, Ecuador and Perú. Specimens are regularly found on a variety of rodents and less commonly on marsupials. Our material contains specimens from 12 species of mammals, indicated above. Other hosts in the literature for this species are the following: *Philander opossum, Marmosa, Akodon, Chilomys, Rheomys, Stictomys,* and *Sigmodon.* The variety of hosts on which fleas of this species are found indicates a low degree of host specificity.

##### TRIBE ADORATOPSYLLINI

*Adoratopsylla (Tritopsylla) intermedia copha* Jordan
(Figure 9)

*Stenopsylla intermedia copha* Jordan, 1926, Novit. Zool., 33: 391, Fig. 15.

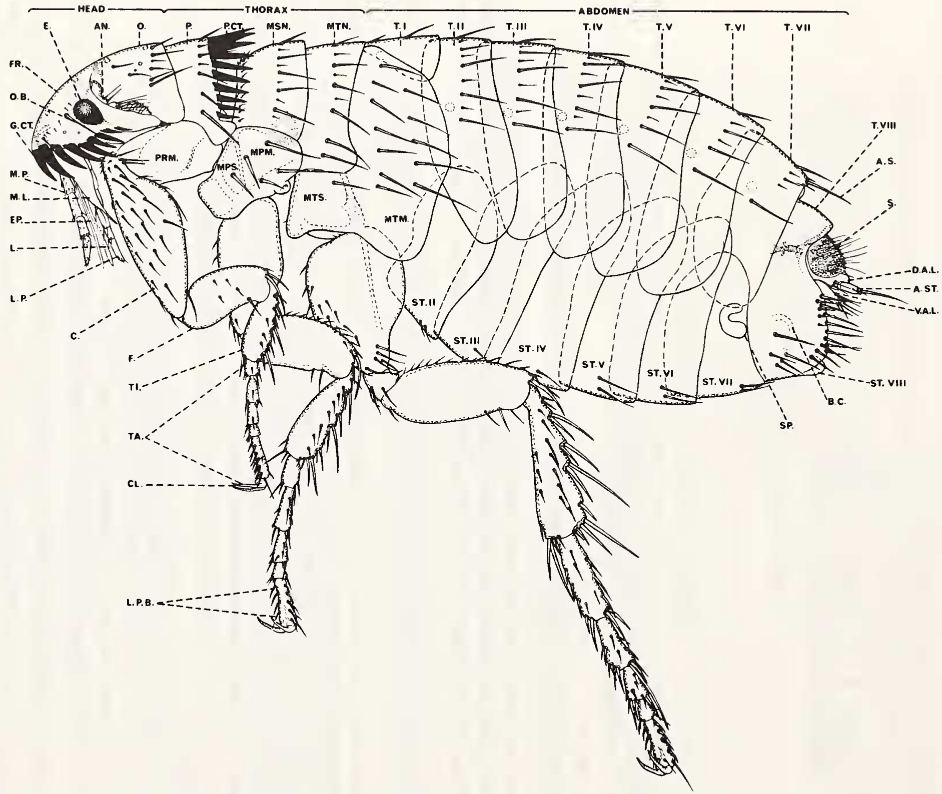


Fig. 6. General appearance of female of *Ctenocephalides felis* (Bouché). AN. - Antenna, A.S. - Antesensilial seta, A.S.T. - Anal stylet of female, B.C. - Bursa copulatrix, C. - Coxa, CL. - Claw of tarsus, D.A.L. - Dorsal anal lobe, E. - Eye, EP. - Epipharynx, F. - Femur, FR. - Frons, G.CT. - Genal ctenidium, L. - Lacinia, L.P. - Labial palp, L.P.B. - Lateral plantar bristles, M.L. - Maxillary lobe, M.P. - Maxillary palp, MPM. - Mesepimere, MPS. - Mesepisternum, MSN. - Mesonotum, MTM. - Metepimere, MTN. - Metanotum, MTS. - Metasternum, O. - Occiput, O.B. - Ocular bristle, P. - Pronotum, P.CT. - Pronotal ctenidium, PRM. - Proepimere, S. - Sensilium, SP. - Spermatheca, ST. - Sternum, T. - Tergum, TA. - Tarsus, TI. - Tibia, V.A.L. - Ventral anal lobe.

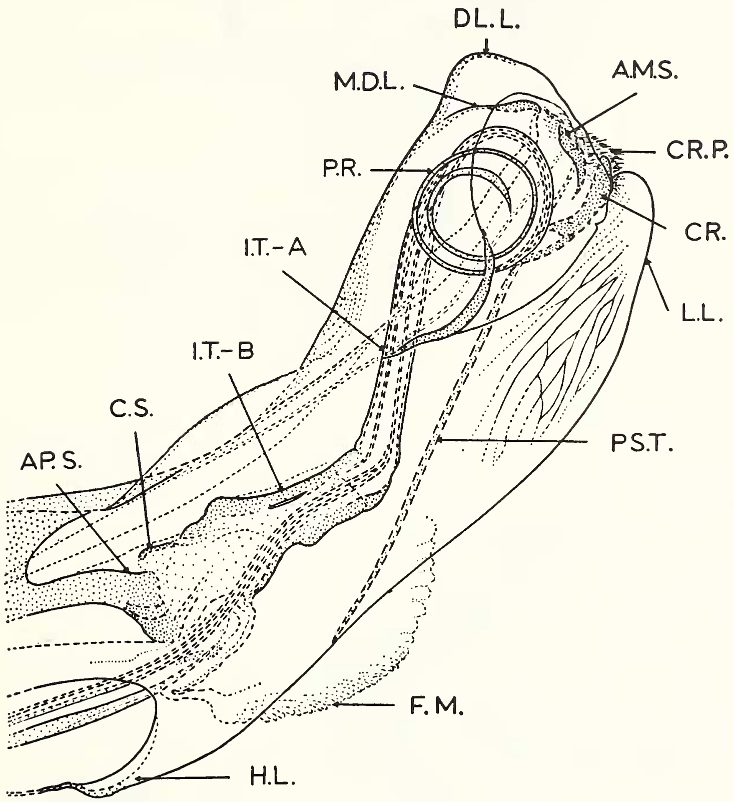


Fig. 7. Structures of apex of aedeagus of *Scolopsyllus colombianus* Méndez. A.M.S. - Apico-median sclerite, AP.S. - Apodemal strut, CR. - Crochet, Cr.P. - Crochet processes, C.S. - Crescent sclerite, DL.L. - Distolateral lobes, F.M. - Fluted membrane, H.L. - Heel at base of aedeagal pouch, I.T.-A - Apical portion of sclerotized inner tube, I.T.-B - Basal portion of inner tube, L.L. - Lateral lobes, M.D.L. - Median dorsal lobes, P.R. - Penis rods, PS.T. - Pseudotube.


Fig. 8. *Neotyphloceras rosenbergi* (Rothschild). Female. A. Head, prothorax and procoxa; B. Modified abdominal segments; C. Spermatheca.

*Material examined.* – *Ex Didelphis azarae.* Depto. del Valle – 3♂, 3♀, vic. Cali, X.

*Ex Didelphis marsupialis.* Depto. del Valle, Municipio de la Cumbre – ♂, ♀, La Maria, 1400 m, XI; Municipio de Cali - 7♂, 7♀, Pichindé, 1600 m., VIII; 10♂, 15♀, Lago Calima, 1450 m., II.

*Ex Philander opossum.* Depto. del Valle – Pichindé, 1600 m., VIII; 3♀, Alto Anchicayá, 650 m., II.

*Ex Oryzomys caliginosus.* Depto. del Valle – ♂, Pichindé, 1600 m., I.

*Ex Thomasomys fuscatus.* Depto. del Valle – 2♂, 3♀, Saladito, (Km. 12), 2000 m., II.

*Remarks.* – This subspecies has been reported from Colombia, Panamá, Ecuador and Perú, from sea level to over 3000 meters. It is a common parasite of marsupials and displays a high degree of infestation on some single host animals (Tipton and Méndez, 1966). In southwestern Colombia specimens have been obtained from the hosts indicated above. Elsewhere specimens have been recorded from *Oryzomys caliginosus* and *Proechimys semispinosus.*

## FAMILY PYGIOPSYLLIDAE

### SUBFAMILY PYGIOPSILLINAE

#### *Ctenidiosomus rex* Johnson

*Ctenidiosomus rex* Johnson, 1957, Mem. Ent. Soc. Wash. 5:50, P1. 20.

*Remarks.* – Type material (2 males and 2 females) from San Agustín, Departamento de Huila, Colombia, represents the only specimens known of this taxon. These specimens were collected from *Thomasomys, Oryzomys* and *Rhipidomys.* It seems probable that a species of *Thomasomys* (probably *T. laniger*), is the natural host of this flea species.

#### *Ctenidiosomus traubi* Johnson
(Figure 10)

*Ctenidiosomus traubi* Johnson, 1957, Mem. Ent. Soc. Wash. 5:49-50, P1. 17; P1. 18, Fig. 5; P1. 19, Fig. 1, 2.

The original description is based on the holotype female, *ex Caenolestes obscurus*, Colombia, Depto. de Antioquia, Sansón, 7 km. E. of Páramo, 3,160 m., 18 Oct. 1950, P. Hershkovitz collector. Males are described below.

*Material examined.* – *Ex Caenolestes obscurus.* Depto. del Cauca – ♀, Puracé Park, 3520 m., V.

*Ex Thomasomys aureus.* Depto. del Cauca – ♂, Pilimbala, 3100 m., V.

*Ex Thomasomys cinereiventer.* Depto. del Nariño – ♂, Comisaría Putumayo, Km. 77, between Sibundoy & Mocoa, 2200 m., V.

*Description of male.* – Head (Fig. 10A). Strongly fracticipit, with frons evenly rounded, without clypeal tubercle. Preantennal region with 3 distinct discs and abundant micropores; principal bristles of preantennal region arranged in 2 rows, secondary bristles very short, scattered mainly on preocular area. Eye deeply excised ventrally, weakly pigmented. Postocular area with 2 pits just below eye. Genal area bilobed, its anterior lobe or genal process broadly rounded, not accuminate. Posterior lobe of gena evenly rounded, moderately broad. Postantennal region with anterior micropores, several pits profusely distributed, 2 rows of bristles, in addition to short bristles on dorsal margin and in front of antenna, mainly on antennal fossa. Pedicellus of antenna covered with short bristles.

Thorax. Very setose. Pronotum with 2 rows of bristles preceding comb of about 26 spines. Mesonotum at least with 3 well defined rows of bristles, remaining bristles short, concentrated on anterior pronotal region. Mesepisternum with few non-prominent bristles on anterodorsal area near pleural ridge of mesothorax. Mesepimere with bristles of different sizes. Metanotum with about 3 or 4 defined rows of bristles, posteriormost row of long bristles and short intercalaries. Other bristles not arranged in rows in anterior metanotal area. Lateral metanotal area apparently with no more than 1 bristle. Metepisternum with oval outline interrupted by anterior projection of metasternum, provided with few bristles. Metepimere with 3 rows of uneven bristles.

Abdomen. Combs on terga II-V, and with various number of spines (in the two specimens examined), respectively, 14-15; 14-15; 12-13; 14-15. Upper antesensilial birstle about 1/2 as long as lower bristle.

Modified abdominal segments. Tergum VIII reduced to subtriangular plate provided with broad spiracle, with group of short bristles near antesensilial bristles. Sternum VIII large, ensheating principal structures of genitalia, provided with numerous marginal and inner bristles, caudal margin entire, without sinus. Clasper large, somewhat pyriform, projected anteriorly into short manubrium curved upward. Process with subrounded apical expansion, largely squamose, with group of bristles on outer and inner surfaces. Posterocaudal margin of process with four long bristles. Movable process of clasper broadest near basal area, narrowed apically, with bristles of varied size. Sternum IX (Fig. 10B) like those of other males of genus. Distal arm club-shaped, with broad and rounded apex with 4 stout bristles on caudal margin; remaining bristles smaller,

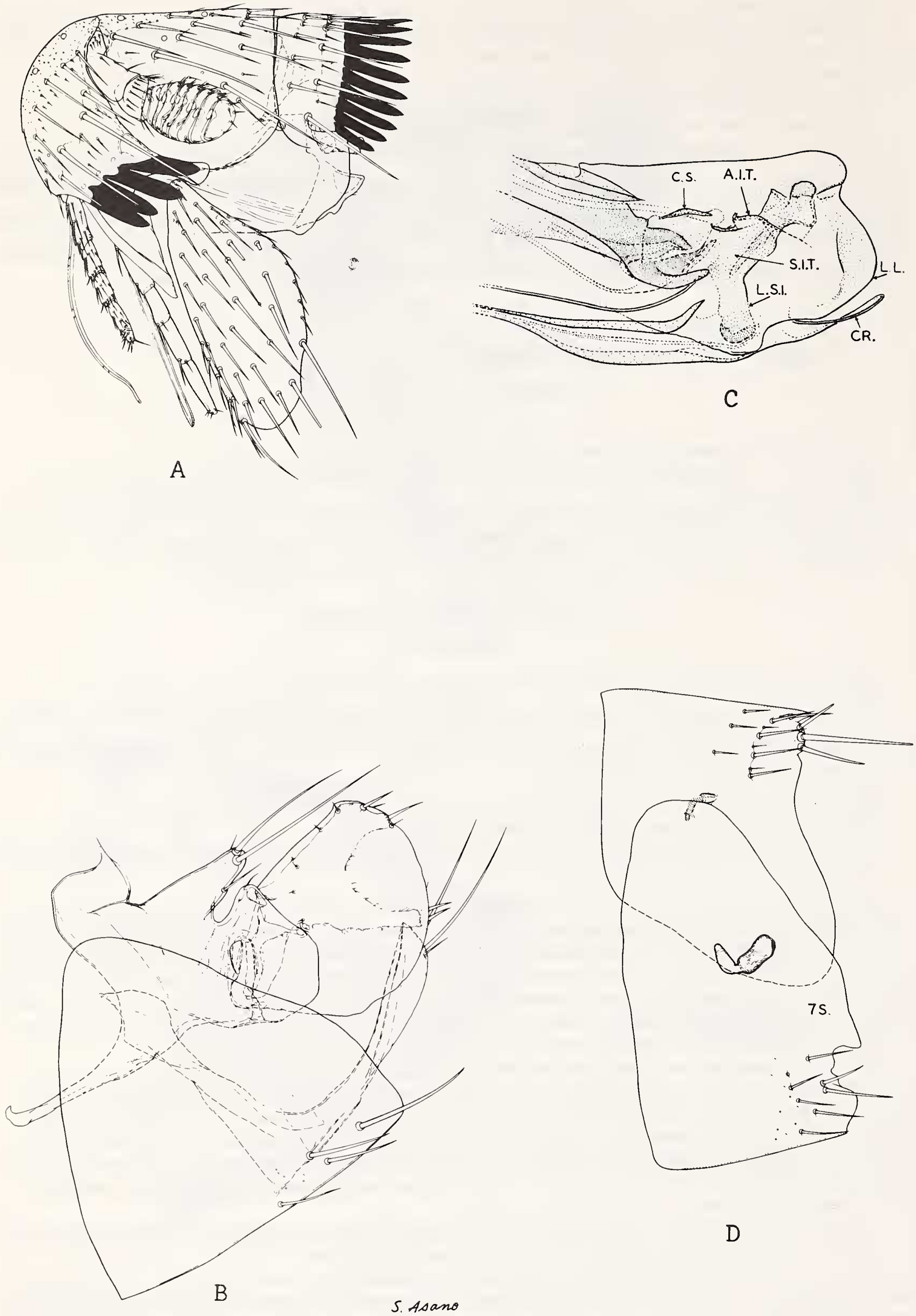


Fig. 9. *Adoratopsylla intermedia copha* Jordan. Male. A. Head, prothorax and procoxa; B. Genitalia; C. Apex of aedeagus, A.I.T. - Armature of inner tube, CR. - Crochet, C.S. - Crescent sclerite, L.L. - lateral lobes, L.S.I. - Lateral sclerotization of inner tube, S.I.T. - Sclerotized inner tube. Female. D. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

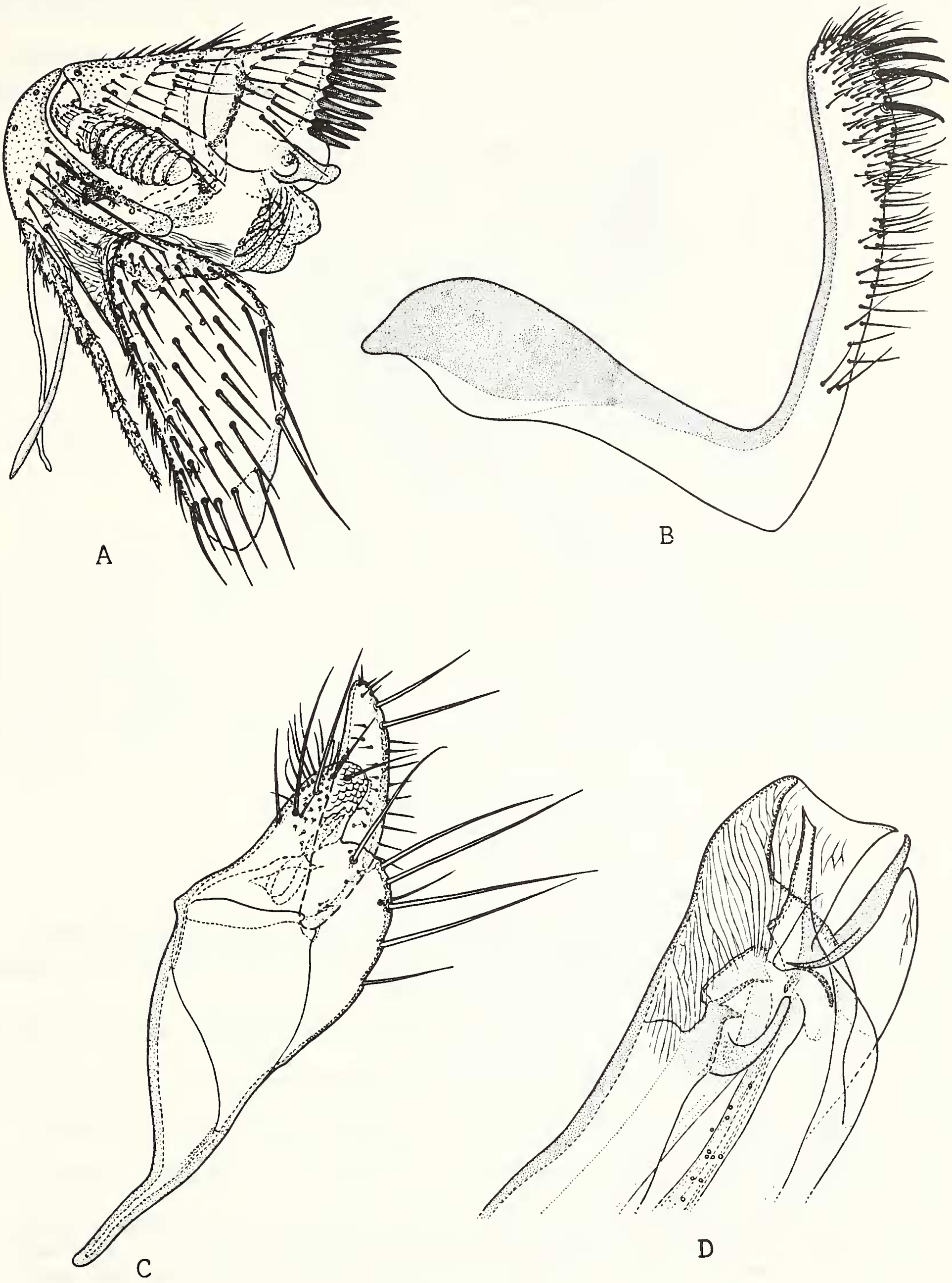


Fig. 10. *Ctenidiosomus traubi* Johnson. Male. A. Head, prothorax and procoxa; B. Ninth sternum; C. Clasper; D. Apex of aedeagus.

scattered over most of arm. Proximal arm of sternum IX narrow at base, broad at apex. Aedeagus like that of *Ctenidiosomus perplexus* Tipton and Machado-Allison. Median dorsal lobe broad, with rounded dorsal margin, produced as caudal subacuminate blade. Lateral lobes narrower than distal lobe, slightly arched. Crochets crescent-shaped. Aedeagal apodemal rod arched apically. Penis rods strongly coiled, extensively fimbriate on apical portion.

*Remarks.* – Presently, *Ctenidiosomus traubi* is known only from Colombia, where it has been collected in localities with elevation ranging from 2200 m to 3500 m. The scant material available has been collected from one marsupial and two cricetine rodent species. As Lewis (1974) pointed out, it is likely that the preferred hosts of *C. traubi* are rodents.

## FAMILY STEPHANOCIRCIDAE
### SUBFAMILY CRANEOPSYLLINAE
#### TRIBE CRANEOPSYLLINI

*Cleopsylla monticola* Smit
(Figure 11)

*Cleopsylla monticola* Smit, 1953, Bull. Brit. Mus. (Nat. Hist.) Entomol., 3(5):193, Fig. 13, 15, 17, 19, 20.

*Material examined.* – *Ex Oryzomys albigularis.* Depto. del Cauca – ♂, ♀, Cerro Munchique, 60 km. by road W. Popayán, sitio No. 1, 2500 m., V. Depto. del Valle – 13♂, 6♀, Finca Holanda (nr. Páramo de Chinche), 2700 m., X.

*Ex Rhipidomys similis.* Depto. del Valle – 2♂, ♀, Finca Holanda, 2700 m., V.

*Ex Thomasomys cinereiventer.* Depto. del Nariño – 2♂, ♀, Laguna de La Cocha, 2700 m., V.

*Ex Thomasomys fuscatus.* Depto. del Valle – ♂, Pichindé, Finca La Flora, 1900 m., V.

*Remarks.* – Reports of this helmet flea are from Ecuador, Colombia and Venezuela. In Colombia, specimens have not been collected above 2700 meters elevation. The range of vertical distribution for this species in Venezuela is from 120 meters to 1443 meters (Tipton and Machado-Allison, 1971). Five species of cricitines harbor *C. monticola* in southwestern Colombia. (see above for details) Other hosts recorded in the literature are *Caenolestes fuliginosus, Didelphis marsupialis, Marmosa fuscata, M. dryas, Oryzomys minutus, Rhipidomys venustus, Rhipidomys* sp., *Thomasomys hylophilus, T. laniger, T. vestibus, Chilomys instans,* and birds.

*Sphinctopsylla diomedes* Johnson
(Figure 12)

*Sphinctopsylla diomedes* Johnson, 1957, Mem. Ent. Soc. Wash. 5:68, P1. 32.

This species was originally described from two male specimens *ex Caenolestes obscurus,* Colombia: Depto. of Huila, San Agustín, San Antonio, left bank of Rio Magdalena (Cordillera Central), 2200 m, 24 Aug. 1950. P. Hershkovitz collector.

*Material examined.* – *Ex Caenolestes obscurus.* Depto. del Cauca – 8♂, 7♀, Puracé Park, 3500 m., IV-VI. Depto. de Cundinamarca, Municipio de Soacha – ♀, Soche, 2700 m., IX.

*Description of female.* – Head (Fig. 12A). Frons marginmoderately rounded. Helmet comb of 13 spines. Genal comb of 5 spines.

Thorax. Pronotum (Fig. 12A) with 2 rows of bristles and conspicuous comb of 9 spines per side. Remaining thoracic structures and legs as in male.

Abdomen. Terga I-IV with apical spineletes. All terga with two rows of bristles but anteriormost row more reduced. Tergum VII with 2 subequal antesensilial bristles.

Modified abdominal segments (Fig. 12B). Posterior margin of tergum VIII sinuous, with 2 groups of large, stout spiniform bristles, upper group of 4-6 bristles, lower group of 1-3. Both groups preceded by scattered bristles of various size and location, in addition to short and moderate size marginal bristles. Spiracle of tergum VIII with very broad basal portion. Sterna II-VI with 1 row of 6 bristles. Sternum VII with group of 3-4 stout spiniform bristles on each side, in addition to several inconspicuous bristles. Posterior margin of this sternum almost straight, not indented. Sensillum with about 11 sensory pits per side. Dorsal anal lobe with several bristles. Ventral anal lobe with only 1 or 2 bristles. Anal stylet short and stout, dorsally and ventrally convex, its apical bristle about twice the length of stylet body, with minute ventral bristle and mesal bristle of moderate size. Spermatheca (Fig. 12B, 12C) with divided bulga, anterior section globular, fairly reticulate, and posterior section not reticulate, followed by short, upturned unpigmented hilla. Main body of bursa copulatrix short, sinuous, weakly sclerotized.

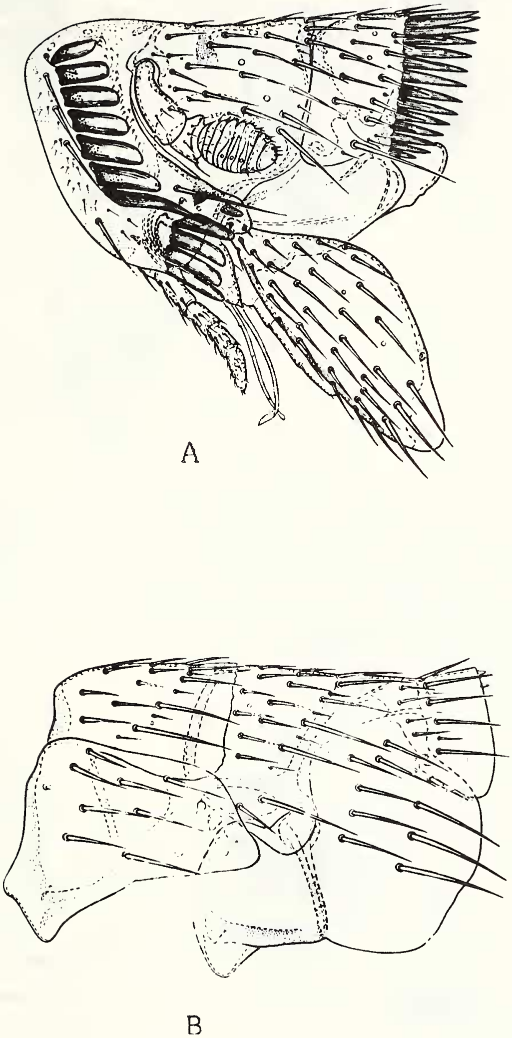


Fig. 11. *Cleopsylla monticola* Smit. Male. A. Head, prothorax and procoxa; B. Mesothorax, metathorax and tergum I.

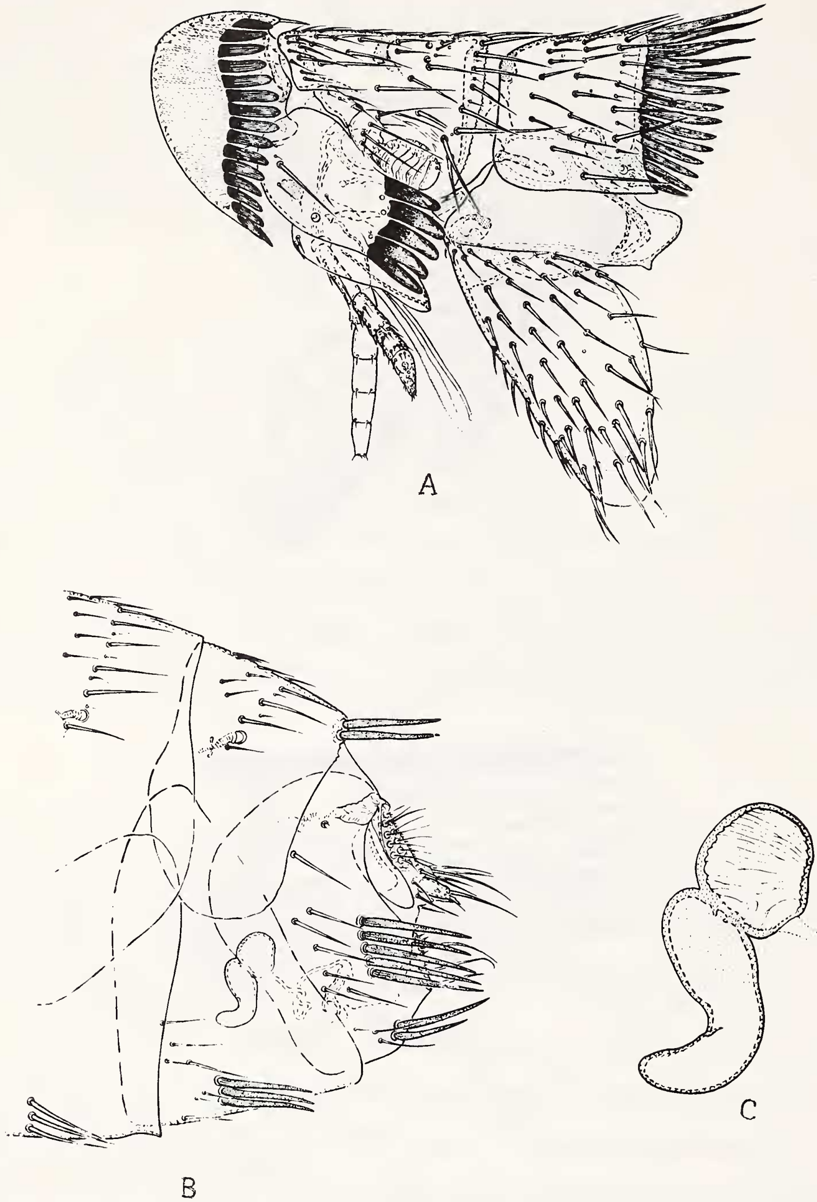


Fig. 12. *Sphinctopsylla diomedes* Johnson. Female. A. Head, prothorax and procoxa; B. Modified abdominal segments; C. Spermatheca.

*Remarks.* – This species is endemic to southwestern Colombia where specimens have been found in areas between 2200 and 3500 meters. All specimens presently existing in collections are from *Caenolestes obscurus* individuals, which seem to be the natural host.

*Sphinctopsylla tolmera* (Jordan)

*Craneopsylla tolmera* Jordan, 1931, Novit. Zool., 36:314, Fig. 5.

*Material examined.* – *Ex Thomasomys cinereiventer.* Depto. del Nariño – ♂, ♀, Laguna de La Cocha, 2700 m., V. Depto. del Valle – ♂, Finca Holanda (nr. Páramo de Chinche), 2700 m., X.

*Remarks.* – The geographical range of *S. tolmera* involves Colombia, Ecuador and Venezuela, in some areas exceeding 2000 meters elevation. Rodents of the genus *Thomasomys* probably are the preferred hosts in Colombia and Ecuador. In Venezuela this flea species seems to be more associated with *Oryzomys minutus.* Of 36 males and 76 females recorded by Tipton and Machado-Allison (1972), 32 males and 63 females were recovered from 46 specimens of this rodent species.

*Plocopsylla phyllisae* Smit
(Figure 13)

*Plocopsylla phyllisae* Smit, 1953, Bull. Brit. Mus. (Nat. Hist.) Entomol., 3:197, Fig. 25, 26, 28, 30.

*Material examined.* – *Ex Caenolestes obscurus.* Depto. del Cauca – 7♂, 11♀, Puracé Park, 3500 m., IV, V. Depto. de Cundinamarca, Municipio de Soache – 2♀, El Soche, 2700 m., IX.

*Remarks.* – Some populations of this species live in territories over 3000 meters elevation in Ecuador and Colombia. The holotype male was secured from *Oryzomys* sp; nevertheless, the material (11♂♂ and 21♀♀ ) available to us for study came from six specimens of *Caenolestes obscurus,* which is probably the preferred host. Individuals of this terrestrial marsupial live in dark damp forests of páramos and are crepuscular or nocturnal. They seem to be primarily insectivorous (Osgood, 1921; Tate, 1931).

*Plocopsylla thor* Johnson
(Figure 14)

*Plocopsylla thor* Johnson, 1957, Mem. Ent. Soc. Wash., 5:73-74, P1. 38 (Fig.1, 2, 3, 6, 7), P1. 39 (Fig. 1, 2, 3).

*Material examined.* – *Ex Thomasomys cinereiventer.* Depto. del Cauca – ♀, Cerro Munchique, 60 km. by road W. Popayán, sitio No. 3, V. Depto. de Nariño – Laguna de La Cocha, 2700 m., V.

*Remarks.* – *Plocopsylla thor* seems to be restricted to areas of high elevation (particularly between 2000 and 3000 meters) in Colombia. Specimens have been found associated with cricetine rodents of the species *Oryzomys albigularis* and *Thomasomys* spp. The typical host for this flea is probably *Thomasomys cinereiventer.*

FAMILY ISCHNOPSYLLIDAE
SUBFAMILY ISCHNOPSYLLINAE

*Sternopsylla distincta speciosa* Johnson
(Figure 15)

*Sternopsylla distincta speciosa* Johnson, 1957, Mem. Ent. Soc. Wash. 5: 100; P1. 48, Fig. 3, 4; P1. 50, Fig. 3, 8.

*Remarks.* – The description of this subspecies is based on a holotype male, an allotype female, and three female paratypes *ex Tadarida brasiliensis*, Perú: Dept. of Cuzco, Quince Mil, 19 June 1950, C. Kalinowski collector. One male and three female paratypes *ex Tadarida* sp., Colombia: Dept. of Huila, Pitalico, 1350 m, 28 Nov. 1951, P. Hershkovitz collector. No other

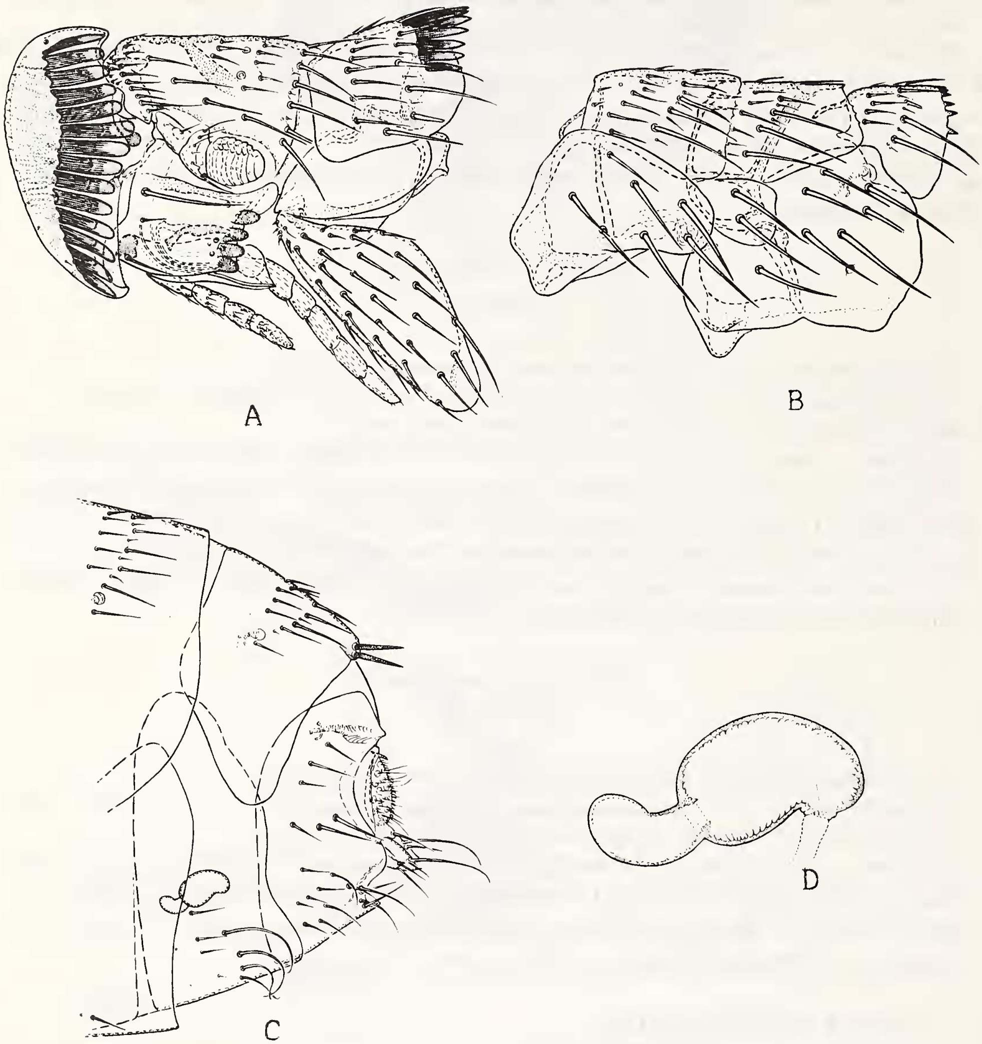


Fig. 13. *Plocopsylla phyllisae* Smit. Male. A. Head, prothorax and procoxa; B. Mesothorax, metathorax and tergum I; C. Modified abdominal segments; D. Spermatheca.

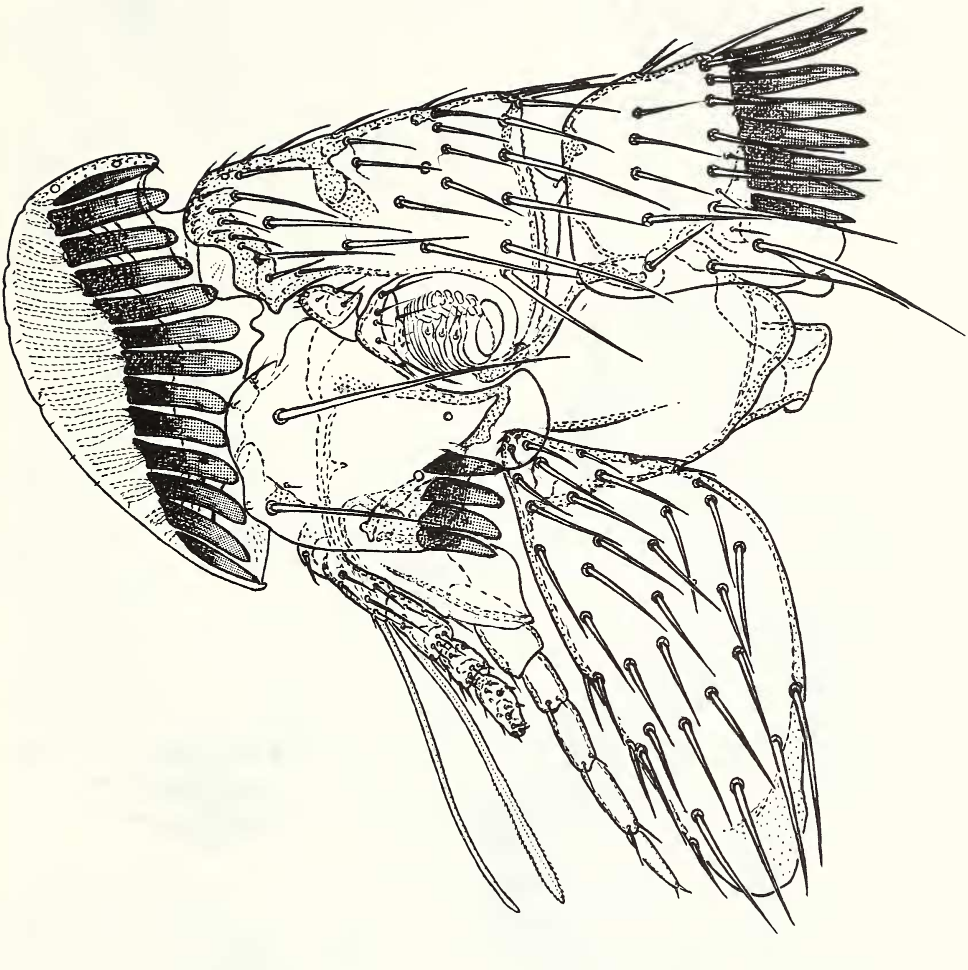

Fig. 14. *Plocopsylla thor* Johnson. Male. Head, prothorax and procoxa.

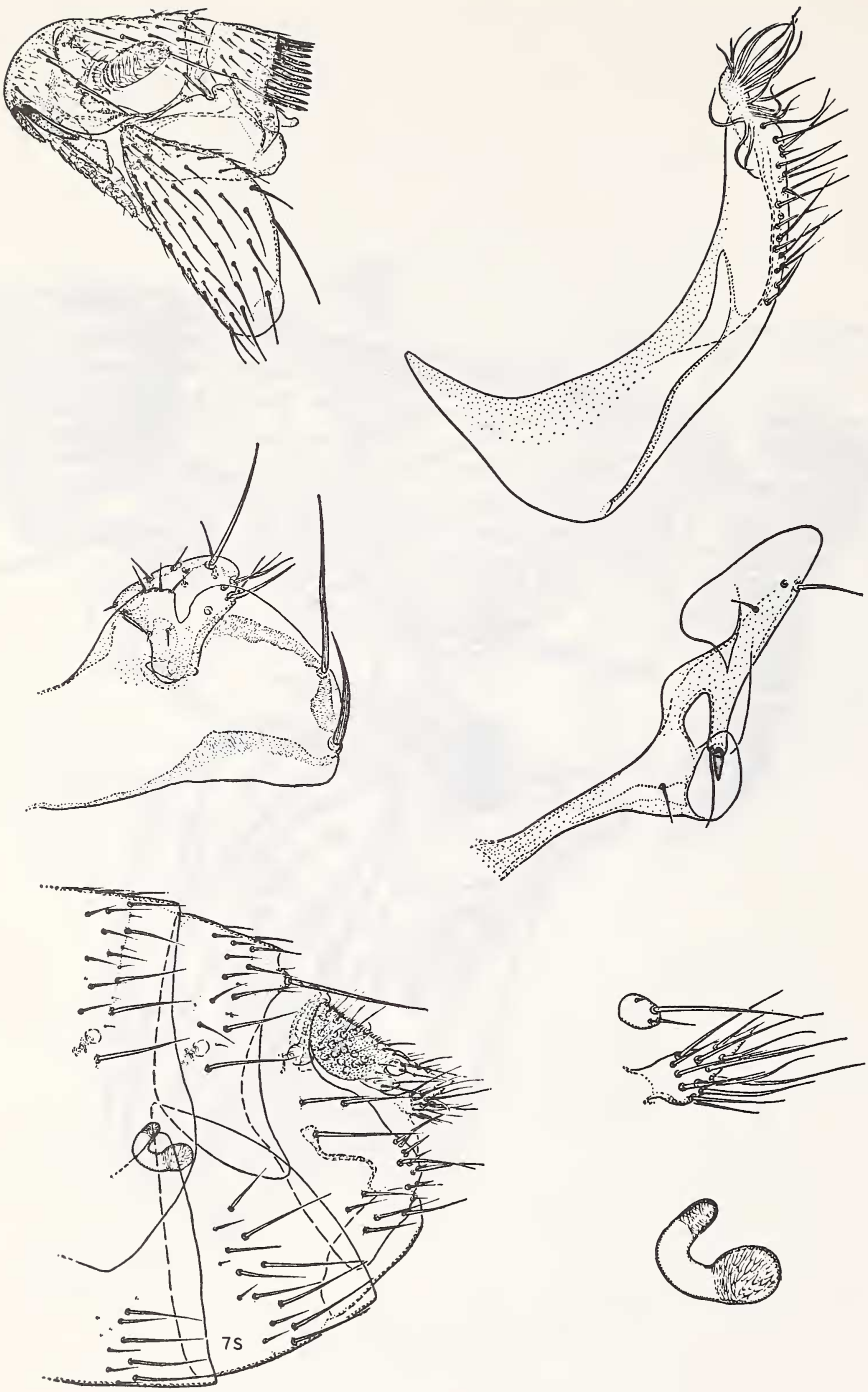


Fig. 15. *Sternopsylla distincta speciosa* Johnson. Male. A. Head, prothorax and procoxa; B. Eight sternum; C. Process and movable finger of clasper; D. Distal arm of ninth sternum. Female. E. Modified abdominal segments; F. Anal stylet and ventral anal lobe; G. Spermatheca. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

Colombian records are mentioned in the literature.

FAMILY CERATOPHYLLIDAE
SUBFAMILY LEPTOPSYLLINAE

*Leptopsylla segnis* (Schönherr)
(Figure 16)

*Pulex segnis* Schönherr, 1811, K. svenska Ventenskakad. Handl. (2) 32:98, Pl. 5, Fig. A. B.

*Material examined.* – *Ex Rhipidomys latimanus.* Depto. del Valle, Municipio de Cali – ♀, Quebrada Honda, nr. Pichindé, 1800 m., IX.

*Ex Rattus rattus.* ♂, same locality as above.

*Remarks.* – *Leptopsylla segnis* is a cosmopolitan species which has been introduced with commensal rodent hosts to many parts of the world. In South America it seems to be confined to areas of high elevation in Colombia, Ecuador, Perú, Venezuela, Brazil, Chile and Argentina. Typical hosts are various species of Muridae; however, the true host is the house mouse, *Mus musculus.*

SUBFAMILY CERATOPHYLLINAE

*Dasypsyllus gallinulae perpinnatus* (Baker)
(Figure 17)

*Ceratophyllus perpinnatus* Baker, 1904, Proc. U.S. Nat. Mus., 27: 386, 391, 445, Fig. 1-6.

*Material examined.* – *Ex Thomasomys cineriventer.* Departo. del Cauca, Cerro Munchique – ♂, 60 km. by road W. Popayán, sitio No. 1, 2500 m., V; ♂, sitio No. 3, 2500 m., V; ♀, Peña del Perro, 2160 m., V.

*Remarks.* – *Dasypsyllus gallinulae perpinnatus* is a widespread bird flea species, recorded from several countries in the New World. Our specimens represent the first report of this taxon for Colombia. It is also known from Canada, United States of America, Panamá, Venezuela and Argentina.

Our specimens were obtained from different sites and dates on three *Thomasomys cinereiventer* specimens. These rodents were trapped on the ground; however, the fact that they were parasitized by this bird flea suggests that *T. cinereiventer* is perhaps partly arboreal. The fleas were probably obtained from bird nests located on trees visited by the rodents. At the present time little is known about the habits of *T. cinereiventer.*

*Pleochaetis equatoris equatoris* (Jordan)

*Ceratophyllus equatoris* Jordan, 1933, Novit. Zool., 38: 344, Fig. 63, (*partim*).

*Material examined.* – *Ex Thomasomys cinereiventer.* Depto. del Nariño – ♀, Laguna de La Cocha, 2700 m., V; ♀, Km. 77, between Sibundoy & Mocoa, Comisaria de Putumayo, 2200 m., V.

*Remarks.* – *Pleochaetis equatoris equatoris* has been reported from Perú, Ecuador and Colombia. According to Johnson (1957), it is likely that specimens from Perú assigned by Macchiavello (1948) to *P. equatoris equatoris* are *P. dolens quitanus.*

*Pleochaetis smiti* Johnson
(Figure 18)

*Pleochaetis smiti* Johnson, 1954, Jour. Wash. Acad. Sci., 44(9): 291, 295, Fig. 1, 3, 6-8, 10, 12, 13, 16, 21, 25, 26, 31.

*Material examined.* – *Ex Caenolestes obscurus.* Depto. del Cauca – ♀, Puracé Park, 3500 m., IV.

*Ex Oryzomys albigularis.* Depto. del Cauca – ♂, Cerro Munchique, 60 km. by road W. Popayán, sitio No. 3, 2500 m., V. Depto del Valle – 2♂, 2♀, Finca Holanda (nr. Páramo de Chinche), 2700 m., X.

*Ex Thomasomys cinereiventer.* Depto. de Nariño – ♂, Laguna de La Cocha, 2700 m., V; Comisaria de Putumayo – ♀, Km. 38, between Pasto & Sibundoy, 3100 m, V; ♂, Km. 77, between Sibundoy and Mocoa, 2200 m., V.

*Remarks.* – *P. smiti* is to date known from Colombia, Ecuador and Venezuela. Judging from our collection and the data available in the literature, the vertical distribution of this species extends from 1980 to 3810 meters. Tipton and Machado-Allison (1972) report abundant material (203 males and 208 females) from Venezuela. Evidence is presented by these authors that the characteristic host of *P. smiti* in Venezuela is *Oryzomys minutus*. They recovered 364 specimens of *P. smiti* from 158 specimens of this rodent.

I suspect that in Colombia, *P. smiti* is probably more specific on *Oryzomys albigularis*; however, flea specimens collected in this country are few and do not allow final interpretation as to preferred host species.

## SUPERFAMILY RHOPALOPSYLLOIDEA

### FAMILY RHOPALOPSYLLIDAE

#### SUBFAMILY RHOPALOPSYLLINAE

##### TRIBE PARAPSYLLINI

*Tetrapsyllus comis* Jordan
(Figure 19)

*Tetrapsyllus comis* Jordan, 1931, Novit. Zool., 37:135, Fig. 1.

*Material examined.* – *Ex Caenolestes obscurus.* Depto. del Cauca – 2♀ Puracé Park, 3500 m., V.

*Remarks.* – *Tetrapsyllus comis* was hitherto known only from Ecuador. Our record is the first for the Republic of Colombia. The scant information about this flea does not allow for determination of host preference. We have two females from *Caenolestes obscurus* while the Ecuadorian holotype female was taken on *Sigmodon* sp. Apparently, *T. comis* is a typical member of the Andean fauna of the northwest portion of South America, perhaps limited in its distribution to Colombia and Ecuador. The male of this species remains unknown.

##### TRIBE RHOPALOPSYLLINI

*Polygenis bohlsi bohlsi* (Wagner)
(Figure 20)

*Pulex bohlsi* Wagner, 1901, Hor. Soc. Ent. Ross., 35:21, Pl. 1, Fig. 6.

*Material examined.* – *Ex Oryzomys albigularis.* Depto. del Valle – ♂, Valle del Rio Pichindé, 1700 - 1900 m., III; Saladito (Km. 12), 2000 m., II.

*Ex Oryzomys alfaroi.* Depto. del Valle, Municipio de Buga – 5♂, 7♀, Sonso, 1000 m., V.

*Ex Oryzomys caliginosus.* Depto. del Valle, Municipio de Buga – 14♂, 14♀, Sonso, 1000 m., III, VI. Depto. del Valle, Municipio de Cali – 4♂, 7♀, Valle del Rio Pichindé, 1700 - 1900 m., III, IV, VI, VII, ♂, 5♀, Pichindé, 1800 - 1880 m., I, III, IV, VII. Depto. del Valle – 3♀, La Buitrera, 1000 m., II; 35♂, 47♀, Lago Calima, 1450 m., II, III; ♂, Florida, 8 km. S.E. "La Diana", 1700 m., XII.

*Ex Thomasomys fuscatus.* Depto. del Valle, Municipio de Cali – ♀, Pichindé, IV.

*Remarks.* – Our records of *P. bohlsi bohlsi* extend the range of this taxon which is now known from Colombia, Ecuador, Venezuela, Trinidad, Brazil, Argentina and Paraguay. The majority of our southwestern Colombia specimens are from oryzomine rodents obtained from 1000 to 2000 meters elevation. Tipton and Machado-Allison (1972) suggest that the optimum habitat of this flea species is at elevations between 1000 and 1500 meters and the preferred hosts are cricetine rodents and perhaps more specifically of akodont stock.

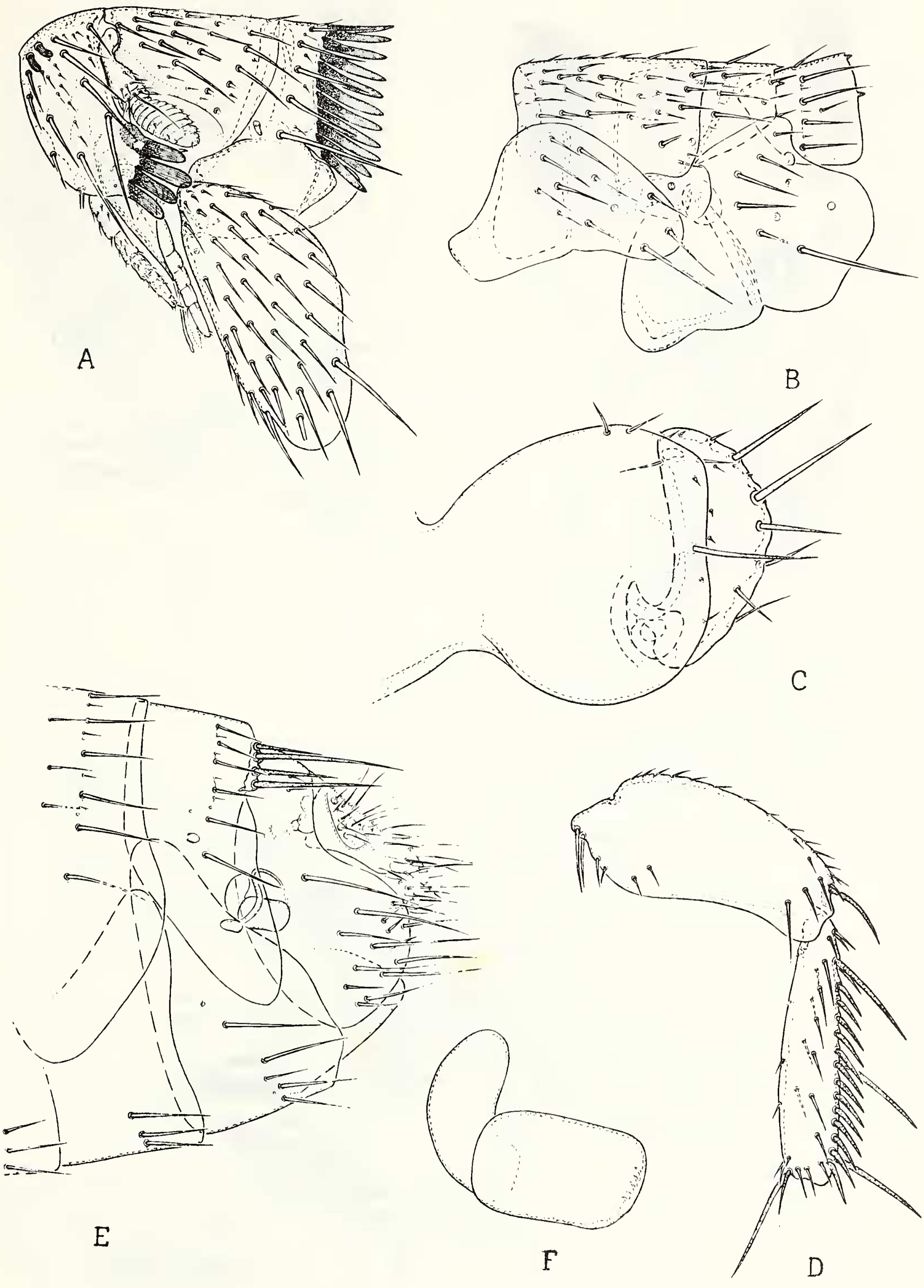


Fig. 16. *Leptopsylla segnis* (Schönherr). Male. A. Head, prothorax and procoxa; B. Mesothorax, metathorax and tergum I; C. Process and movable finger of clasper; D. Hind femur and hind tibia. Female. E. Modified abdominal segments; F. Spermatheca.

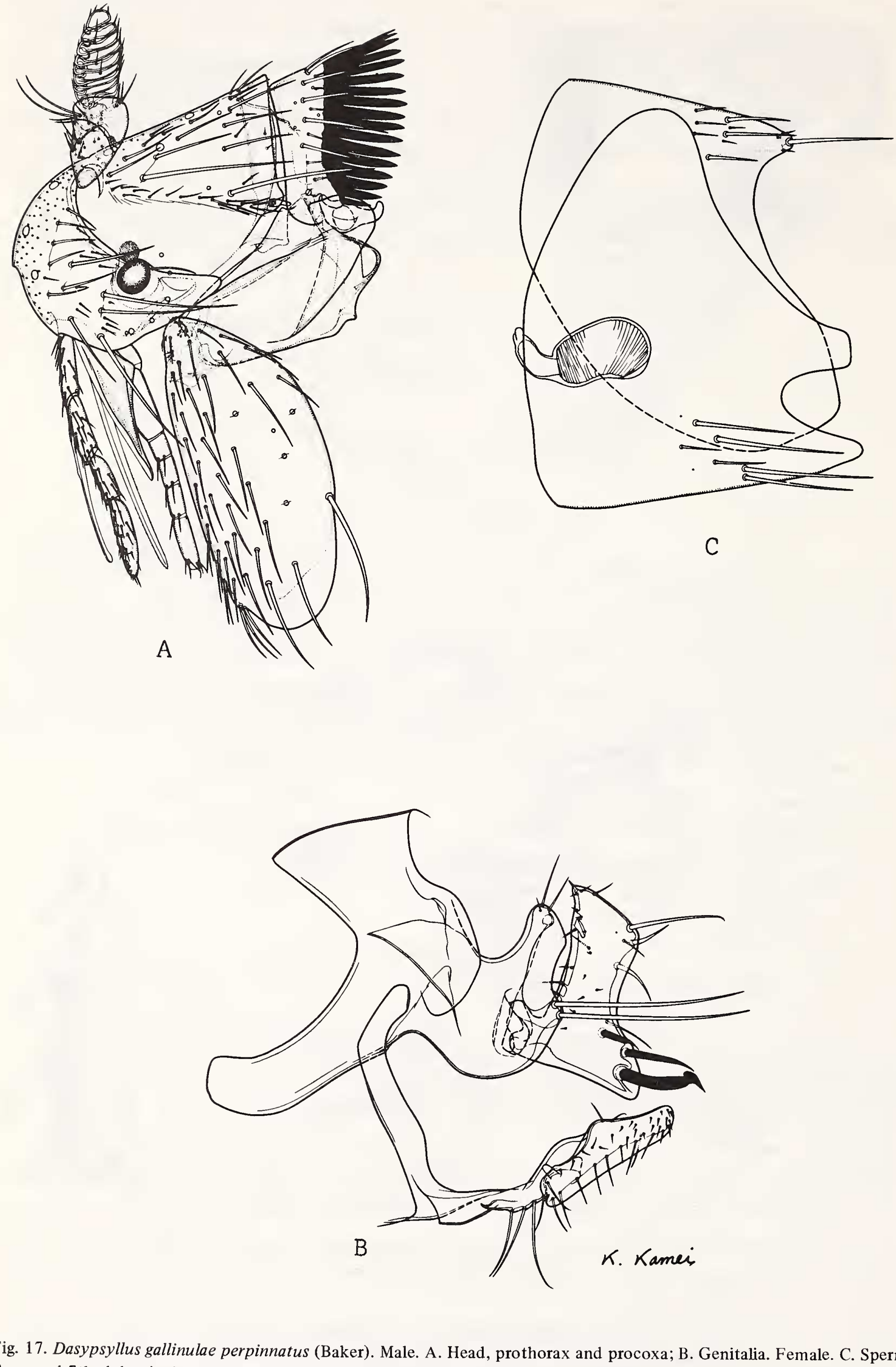


Fig. 17. *Dasypsyllus gallinulae perpinnatus* (Baker). Male. A. Head, prothorax and procoxa; B. Genitalia. Female. C. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

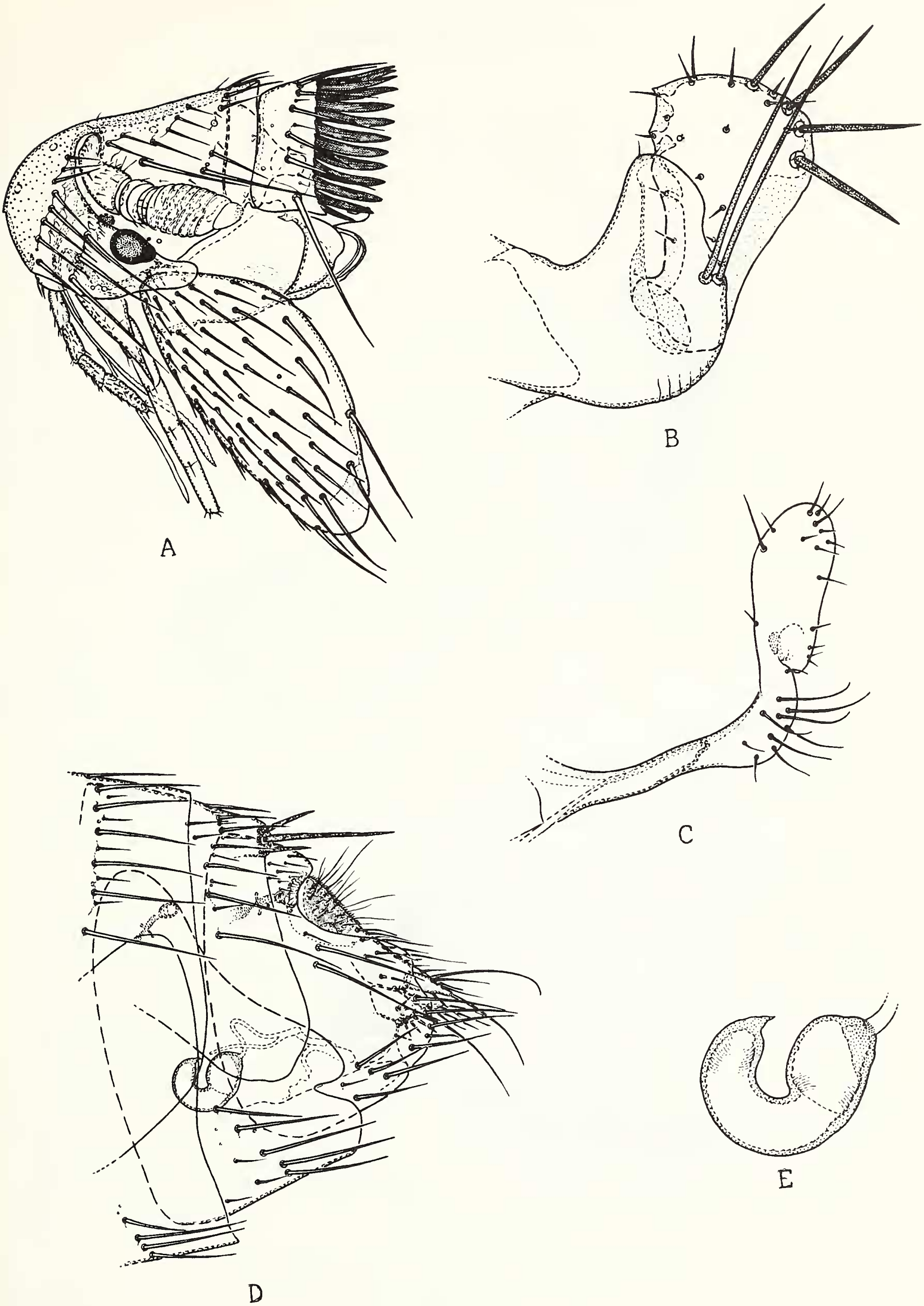


Fig. 18. *Pleochaetis smiti* Johnson. Male. A. Head, prothorax and procoxa; B. Process and movable finger of clasper; C. Distal arm of 9th sternum. Female. D. Modified abdominal segments; E. Spermatheca.

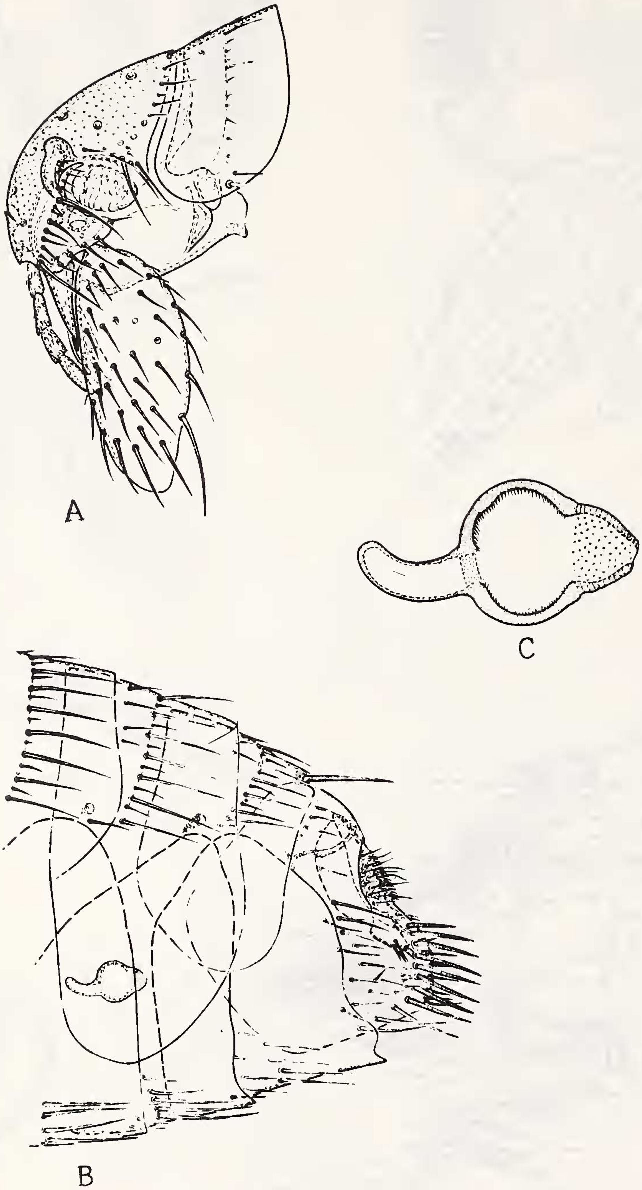


Fig. 19. *Tetrapsyllus comis* Jordan. Female. A. Head, prothorax and procoxa; B. Modified abdominal segments; C. Spermatheca.

### *Polygenis caucensis*, new species (Fig. 21, 22)

*Type material.* – Holotype ♂ *ex Oryzomys caliginosus*, (00036), Alto Anchicayá, 650 m, Depto. del Valle, Colombia, 11.II.1974, E. Méndez & L. Velásquez; allotype ♀, (00032), same locality, date and collector; ♀ paratype, (00042), same locality, date and collector; ♂ paratype (Acc. No. B-571), *ex Didelphis marsupialis*, Curiche River, Depto. del Choco, Colombia, 19.VI.1967, D.G. Young

Holotype and allotype are in the National Museum of Natural History, Washington, D.C.; 1 paratype is in the British Museum (Natural History) and 1 paratype is in the Gorgas Memorial Laboratory's collection.

*Diagnosis.* – This species appears to be closest to *Polygenis roberti beebei* I. Fox. Males are differentiated by the more reticulate aedeagal lateral lobes. In addition, *P. caucensis* males have an aedeagal median dorsal lobe with a subapical ridge, a structure apparently absent from males of *P. r. beebei.*

*Description.* – Male. Head (Fig. 21A). Frons fairly rounded, interrupted by short, angular tubercle protruded upward. Preantennal region with moderate number of micropores and 2 pits in front of antennal scape. Preocular row of 2 bristles inserted near eye. Post-ocular row with few minute bristles on lower and upper portions of preocular region. Arch of tentorium not conspicuous. Oral angle well defined. Genal lobe semiangular. Eyes subovate, not incised, large and well pigmented. Maxilla with acuminate tip extended to last segment of maxillary palp. Post-antennal region with 3 rows of bristles behind antennal scape. Antennae densely covered with minute and prominent bristles irregularly distributed.

Thorax. Pronotum and mesonotum with 2 rows of bristles. Mesepisternum with 2 large bristles per side. Mesepimeron apparently with 2 or 3 bristles per side. Metanotum with 3 rows of bristles. Metanotal flange with about 6 spinelets. Metepisternum with single bristle. Metepimeron with 9 bristles in 2 rows.

Legs. Posteromarginal notches of metatibia with strong bristles with following distribution: 2-2-2-3-2-3.

Abdomen. Terga I-V with spinelets and 2 rows of bristles. Unmodified sterna with single row of bristles, those of sterna II and III preceded by very few marginal and submarginal bristles.

Modified abdominal segments (Fig. 21C). Sternum VIII somewhat reduced, with several unequal bristles. Fixed process of clasper (Fig. 21B) broad, with its total length in excess of maximum width, and with barely projected apical lobe, dorsal margin shallowly sinuate, posterior and ventral margins strongly sinuate, last one moderately indented. Chaetotaxy as illustrated. Movable finger of clasper (Fig. 21B) not extended to apical lobe, with several marginal and inconspicuous inner bristles. Proximal arm of sternum IX shorter than distal arm, of irregular shape, narrowed at basal portion, then considerably expanded and sinuate, terminated in subangular projection. Distal arm of sternum IX (Fig. 22A) curved cephalad, more dilated medially but gradually tapered toward its subrounded tip. Chaetotaxy of this arm limited to some apical bristles and posteromarginal bristles of various sizes. Heel of sternum IX prominent, with slender, straight terminal tendon. Sternum VIII with wide subrounded caudal lobe and single row of unequal bristles. Apodeme of aedeagus (Fig. 22B) broad, shorter than terminal portion of aedeagus, with subrounded apex. Terminal portion of aedeagus (Fig. 22B) with semirounded distolateral lobes. Median dorsal lobe large, almost reaching posterior portion of distolateral lobes, with upper margin shallowly convex. Crochet not apparent. Lateral lobe gently reticulated, broadly curved, except for short basal angular prominence. Side piece prominent, almost triangular, its longest side fairly convex. Fender well sclerotized, arched and conspicuous. Apical portion of inner tube larger than basal portion, strongly convoluted, with final portion slender. Basal portion of inner tube of moderate proportions, with narrow foramen on anterior half. Crescent sclerite short, indistinct. Side piece broad, of irregular shape, with anterior margin convex, posterior margin angulate. Fulcral latero-ventral lobe represented by short, slightly curved knob-like structure. Pseudo tube long, sinuate, well sclerotized. Lateral thickening of end chamber very long, sinuous, reaching heel at base of aedeagal pouch. Heel conspicuous, slightly curved upward, with apex subrounded. Fluted membrane prominent.

Female. Head, thorax, legs and unmodified abdominal somites essentially as in male.

Modified abdominal segments. Tergum VII ventrally expanded beyond longitudinal axis of abdomen, with 2 rows of bristles. Tergum VIII large, with sinuous posterior margin and bristles of different length. Sternum VII with posterior margin subtruncate, with several uneven bristles apparently in single row. Sternum VII broad but not conspicuous, with subangular caudal margin. Dorsal anal lobe and ventral anal lobe both with subtruncate apex and several bristles. Anal stylet about two times as long as maximum width, with 2 minute ventral bristles preceding long apical bristle. Spermatheca (Fig. 22C) with humped bulga well delimited from short, upturned hilla. Dorsal margin of bulga and apex of hilla respectively with short projection.

Length. Holotype, 2.96 mm; allotype, 3.31 mm.

*Remarks.* – The trivial epithet of this taxon has been adopted from the Depto. del Cauca, where part of the type material was obtained.

## *Polygenis delpontei,* new species
(Fig. 23, 24, 25)

*Type material.* — Holotype ♂ and allotype ♀(HTC-315) *ex Oryzomys caliginosus*, Colombia, Depto. del Valle, Municipio de Cali, Quebrada Honda near Pichindé, elevation 1800 m, 7.X.1967, H. Trapido. Paratypes: 3 ♀ with same data as holotype; 1 ♂(HTC-146) with same host, locality and collector as holotype but 13.VIII.1965; 1♂, 1 ♀(HTC-212) with same data as holotype but 8.IX.1965; 1 ♀(HTC-213) *ex Reithrodontomys mexicanus,* other data as HTC-212; 1 ♂(HTC-243) with same data as HTC-212 but 16.IX.1965; 1 ♀(HTC-302) *ex Oryzomys (Oligoryzomys)* sp. (?) with same data as HTC-212 but 4.X.1965. Following paratypes with same data as holotype except date: 2♂ (HTC-317) 11.X.1963; 1♀(HTC-330) 19.X.1965; 1♀ (HTC-393) 17.XI.1965; 2♂ (HTC-397) 18.XI.1965; 1♂(HTC-429) with same data as holotype but 29.XI.1965; 1 ♀(HTC-454) with same data as holotype but 14.XII.1965; 1 ♂(HTC-1307) with same data as holotype but 13.XII.1966, 2 ♂(00007) same host, Rincón del Yarumal, Pichindé, Depto. del Valle, 21-25. I. 1974, M. Thomas & L. Velásquez; 1♂(00010), La Buitrera, Depto. del Valle, 7.II.1974, E. Méndez & L. Velásquez; *ex Thomasomys fuscatus,* 1♂, (HTC-2955), Rincón del Yarumal, Pichindé, Depto. del Valle, 8.V.1969, H. Trapido, 1♂, with same host and locality but 28.V.1969; 1♀(00064), Saladito (Km 12), 2000 m, Depto. del Valle, 17.II.1974, E. Méndez & L. Velásquez; 1♂(HTC-805) with same data as holotype but elevation 1700 - 1900 m, 5.II.1966; 1♂(HTC-1317) with same data as HTC-605 but 13.XII. 1966.

Holotype and allotype are in the U.S. National Museum of Natural History. Paratypes are in the collections of the following institutions and specialists; British Museum (Natural History), Universidad del Valle, Colombia, Gorgas Memorial Laboratory, Robert Traub and Phyllis T. Johnson.

*Diagnosis.* — *Polygenis delpontei* is closely related to *P. brachinus* Jordan. It differs from this species primarily in that it has the terminal portion of the aedeagal sclerotized inner tube rod-like and upturned. In *P. brachinus* the terminal portion of the sclerotized inner tube is flat and bent downward.

*Description.* — Male. Head (Fig. 23A). Frons evenly rounded. Frontal tubercle barely projected out of margin, subrounded by wide sclerotized area. Preantennal region profusely covered with micropores. Preantennal row of 7 unequal bristles evenly spaced. Preocular row of 3 medium size bristles and 2 or 3 secondary short bristles. Premarginal bristles of antennal fossa weak, inconspicuous. Oral angle acute but not prominent. Genal lobe subangular. Eye oval, with small ventral indentation and moderate pigmentation. Post antennal region essentially with 3 rows but posteriormost bristle somewhat displaced, thus suggesting 4th row.

Thorax. Pronotum and mesonotum each with 2 rows of bristles, last row with intercalaries. Mesepisternum somewhat reticulated, with 2 bristles. Mesepimeron with 3 bristles. Metanotum with 4 rows of bristles; anterior row reduced to about 3 or 4 bristles. Flange of metanotum with 9 to 11 spinelets.

Legs. Typical of genus. Metatibia with posteromarginal notches with strong bristles arranged from upper to lower as follows: 2-2-2-3-2-3.

Modified abdominal segments (Fig. 23C). Tergum VIII small, with single row of bristles. Sternum VIII relatively large, caudally in form of subangular lobe, with 1 row of 5 to 7 unequal bristles. Caudal flaps of sternum VIII opened at 0.33 of ventral margin. Dorsal and anal lobes of proctiger as in other *Polygenis.* Fixed process of clasper (Fig. 23B) with subangular apical lobe. Dorsal margin barely sinuate, ventral and posterior margins strongly sinuate but without true indentations. Dorsal area of fixed process very setose; rest of bristles of this structure scantly distributed over ventral, posterior and inner areas. Movable process of clasper (Fig. 23B) slightly shorter than distal arm, with broad apex, usually of 3 lobes. Distal arm of sternum IX (Fig. 23A) curved cephalad, with broad base, but with about equal width throughout most of its length, numerous bristles oriented posteriorly. Heel of sternum IX small, with short slender terminal tendon. Apodeme of aedeagus (Fig. 24B) with very broad portion before subrounded apex. Terminal portion of aedeagus (Fig. 24B) with prominent rounded distolateral lobes. Median dorsal lobe with posterior semiangular projection. Crochet indistinct. Lateral lobe broadly convex. Dorsal area of terminal portion of aedeagus with distinct striated section facing apical portion of sclerotized inner tube. Lateral thickening of end chamber sinuous, ended almost at level with basal segment of sclerotized inner tube. Fender long, sinuous and slender. Basal portion of sclerotized inner tube much shorter than apical portion of this tube, with large foramen on posterior half. Ribs scant, with irregular distribution. Crescent sclerite short, sinuous. Fulcral latero-ventral lobe curved caudad, with rounded apex. Heel at base of aedeagal pouch subacute, connected with apodemal rod. Vesicle ventrally expanded into thick ridge of irregular shape. Final section of this ridge apparently receiving anterior portion of fluted membrane. Penis rod coiled, ending on thick nob-like portion. Fluted membrane moderately developed.

Female. Head (Fig. 25A). Frons more evenly rounded than in male. Thoracic structures and legs similar to those of male. Tergum I with 2 or 3 rows of bristles and posteromarginal row of spinelets. Other unmodified abdominal somites as in male.

Modified abdominal segments (Fig. 25B). Sternum VIII moderately developed, extended beyond longitudinal axis of abdomen, with 2 rows of bristles and single antepygidial bristles. Tergum VIII long, with posterior margin somewhat angular, with several postero-marginal and submarginal bristles preceded by long irregular row of bristles. Sternum VII with postero-caudal margin abruptly truncate, not incised, with combination of long and short bristles. Sternum VIII reduced, caudally

truncate. Sternum IX short, with posterior margin straight or barely arched. Dorsal anal lobe of proctiger (Fig. 25C) with truncate apex and prominent apical and subapical bristles. Anal stylet with 2 minute ventral bristles before long apical bristle. Spermatheca (Fig. 25B, D) with cribose bulga clearly separated from short hilla with terminal portion upturned, dilated, semi-globular.

Length. Holotype, 2.04 mm; allotype, 2.01 mm.

*Remarks.* – This species is dedicated to the memory of the late Dr. Eduardo Del Ponte, whose excellent work on Siphonaptera and other blood-sucking insects contributed to the foundation of medical entomology in South America.

## *Polygenis dunni* (Jordan & Rothschild)
(Figure 26)

*Rhopalopsyllus dunni* Jordan & Rothschild, 1922, Ectop., 1:269, Fig. 261, 262.

*Remarks.* – Although this species has not been yet recorded from Colombia, there is a strong possibility that it occurs in this country. It is presently known from Panamá, Venezuela and Trinidad, and parasitizes an assemblage of hosts (see Tipton and Méndez, 1966 and Tipton and Machado-Allison, 1972).

## *Polygenis hopkinsi*, new species
(Fig. 27, 28)

*Type material.* – Holotype male *ex Oryzomys albigularis* (HTC-1838), Cerro Munchique (60 kms by road west of Popayán); Peña del Cerro, elevation 2160 m, Departamento del Cauca, Colombia, 11.V.1967, H. Trapido.

The holotype is in the U.S. National Museum of Natural History.

*Diagnosis.* – Males of *Polygenis hopkinsi* are similar to those of *P. litargus* Jordan & Rothschild, from which they are readily differentiated by having the terminal portion of the sclerotized inner tube bent upward. In *P. litargus* males, this structure ends barely sinuate and oriented cephalad.

*Description.* – Male. Head (Fig. 27A). Frons rounded, its contour not interrupted by unpronounced clypeal tubercle. Preantennal area above clypeal tubercle with micropores. Preantennal row of bristles of 5 bristles, one near antenna exceeds others in size. Preocular row of 3 principal long bristles and short secondary bristles separated from displaced minute bristle inserted near ventral margin. Eye subovate, moderately pigmented, with deep ventral indentation. Tentorium with arched anterior arm preceding principal stem. Oral angle short, acuminate. Tip of maxilla extended to anterior portion of last segment of maxillary palpus. Genal angle subacuminate. Postantennal region with 3 rows of gradually increased number of bristles. Micropores limited to space between antennal base and first row of bristles. Group of short and thin bristles located near scape of antenna.

Thorax. Mesonotum with 3 rows of bristles, first row reduced, of 2 or 3 bristles. Mesepisternum with 2 bristles. Mesepimeron with 3 bristles. Lateral metanotal area with 2 large bristles preceded by 2 short bristles. Metepisternum with single long bristle and group of short bristles on anteromarginal projection.

Legs. As in other *Polygenis.* Metatibia with strong bristles inserted in notches as follows: 2-2-2-3-2-3.

Abdomen. Tergum I with 3 rows of bristles, first row reduced to about 4 bristles. Remaining unmodified terga with 2 rows of bristles. Sternum 1 with scattered ventral, subventral and inner bristles. Other unmodified sterna with single row of bristles.

Modified abdominal segments (Fig. 27C). Tergum VIII short but extended to abdominal axis. Sternum VIII large, with truncate caudomarginal expansion, its ventral division clearly posterior to row of bristles. Fixed process of clasper (Fig. 27B) with dorsal margin moderately sinuate, gradually elevated toward apical portion. Posterior margin of fixed process very undulate, with short semiangular protrusion proximad to fovea of fixed process. Ventral margin deeply indented. Bristles of fixed process as illustrated. Movable finger (Fig. 27B) slightly bent upwards, not extended to apex of fixed process of clasper, clothed with several marginal, submarginal and inner bristles. Distal arm of sternum IX (Fig. 28A) semi-falcate, almost as long as proximal arm, with anterior margin devoid of bristles and posterior margin with bristles of moderate size distributed over half its length. Heel of sternum IX heavily sclerotized, with relatively short tendon. Distolateral lobes of aedeagus (Fig. 28B) with anterior portion subrounded and posterior portion obtuse, prolonged into large ventromarginal extension. Median dorsal lobe with subangular apical portion. Apicomedian sclerite of aedeagus striated. Crochet imperceptible. Lateral lobe undulate, with distinct superior subangular projection. Dorsal area of terminal portion of aedeagus with small striated section facing junction of apical and basal portions of sclerotized inner tube. Lateral thickening of end chamber sinuous, ended at level of vesicle. Lateroventral sclerite sickle-shaped but with rounded tip. Heel at base of aedeagal pouch semi-acuminate, attached to apodemal rod. Fender semi-arched, slender and elongate. Apical portion of sclerotized inner tube with 2

loops, its terminal section wide, upturned, oriented cephalad, with semiglobular apex. Basal portion of sclerotized inner tube with mesal foramen of moderate size. Ventral nodular section of basal portion large and prominent. Ribs distributed from area near vesicle to fender. Crescent sclerite arched, not prominent. Side pieces semi-triangular, with opposite ends acuminate.

Length. Holotype, 2.31 mm.

*Remarks.* – This species is named for the late G.H.E. Hopkins in recognition of the outstanding contributions he made to the systematics of Siphonaptera and Anoplura.

*Polygenis klagesi* (Rothschild)
(Figure 29)

*Pulex klagesi* Rothschild, 1904, Novit. Zool., 11:620, Pl. 9, Fig. 28; Pl. 10, Fig. 35, 39.

*Material examined.* – *Ex Proechimys semispinosus.* Departo. del Valle – ♂, Río Raposo, XI.

*Ex Hoplomys gymnurus.* Depto. del Valle – 11♂, 11♀, Alto Anchicayá, 650 m., II.

In addition to material from the southwest part of Colombia, I have examined 11 males and 17 females from Carimagua, Depto. del Meta, 8 males and 11 females from the Depto. de Antioquia and large series of males and females from Depto. del Chocó.

*Remarks.* – Our specimens of *Polygenis klagesi* taken on *Hoplomys gymnurus* from Alto Anchicayá, Depto. del Valle, and Curiche, Depto. del Chocó, do not agree in certain features with specimens taken on *Proechimys semispinosus* which we are tentatively interpreting as typical *Polygenis klagesi samuelis.* In view of the considerable amount of variation displayed by *P. klagesi*, it is advisable not to try to segregate Colombian populations into subspecies until an adequate study of material obtained throughout the geographical range of these fleas is done.

*Polygenis klagesi* is presently known from Brazil, Panamá, Costa Rica, Colombia, Venezuela, Trinidad and Ecuador, from sea level to altitudes below 900 meters.

The *P. klagesi* complex occurs on a spectrum of hosts; however, these fleas are more naturally associated with the spiny rat family Echimyidae, particularly with *Proechimys.*

*Polygenis pradoi* (Wagner)
(Figure 30)

*Rhopalopsyllus pradoi* Wagner, 1937, Zeits. Parasit., 9:420, Fig. 4.

*Material examined.* – *Ex Oryzomys albigularis.* Depto. del Valle, Municipio de Cali – 2♂, 2♀, Pichindé (La Esperanza), 1900 m., I, VIII.

*Ex Oryzomys caliginosus.* Depto. del Valle, Municipio de Cali – 3♀, Quebrada Honda, nr. Pichindé, 1800 m., IX, X; 9♂, 18♀, Valle del Río Pichindé, 1700 - 1900 m., I, III, VI-XI; 4♂, 11♀, Pichindé, 1780-1900 m., X.

*Ex Rhipidomys latimanus.* Depto. del Valle, Municipio de Cali – ♂, Pichindé, 1900 m., XI.

*Ex Thomasomys fuscatus.* Depto. del Valle, Municipio de Cali – ♀, Valle del Río Pichindé, 1700 - 1900 m., XI.

*Remarks.* – *Polygenis pradoi* has been reported from Brazil. Our specimens from southwestern Colombia represent the first records of this flea species for the country. *Oryzomys (Melanomys) caliginosus*, probably the commonest rodent in southwestern Colombia, stands out as the more favored host in this territory. Of 48 specimens of *P. pradoi* obtained, 42 were from that host while four were taken on *Oryzomys albigularis*, one on *Rhipidomys latimanus* and one on *Thomasomys fuscatus.* The reports of this species from Brazil concern the following hosts: *Nasua socialis, Didelphis cancrivora, Oryzomys physodes, Akodon* sp. (possibly *cursor*), a wild rat and wild mouse (Johnson, 1957).

*Polygenis roberti beebei* (I. Fox)
(Figure 31)

*Rhopalopsyllus beebei* I. Fox, 1947, Zool: N.Y. Zool. Soc., 32:117, Fig. 2.

*Remarks.* – *Polygenis roberti beebei* has not been yet collected in the southwest corner of Colombia; nonetheless, we consider its presence there as probable. This taxon has not been reported from Colombia in the literature; however, we have examined 36 specimens (15 males and 21 females) from the Departamento de Antioquia, kindly loaned by Dr. V.J. Tipton.

The zoogeography of *P. roberti beebei* presently involves Venezuela, Perú, Colombia, Trinidad and Panamá. It has been collected at low and moderate altitudes. The normal hosts of this flea are marsupials and rodents, notably some members of the cricetine genus *Oryzomys*.

### *Polygenis thurmani* Johnson
(Figure 32)

*Polygenis thurmani* Johnson, 1957, Mem. Ent. Soc. Wash. 5:169-170, Pls. 84, 85.

*Material examined.* – *Ex Didelphis marsupialis.* Depto. del Valle – ♂, 2♀, Lago Calima, 1450 m., II.

*Ex Oryzomys albigularis.* Depto. del Valle, Municipio de Cali – ♂, Quebrada Norte, Finca La Flora, Pichindé, 1900 m., VIII; ♂, La Esperanza, Pichindé, VIII; ♂, 2♀, Quebrada Honda, nr. Pichindé, 1800 m., X; 3♂, ♀, Pichindé, 1600 m., I.

*Ex Oryzomys* species (probably *O. caliginosus*). Depto. del Valle, Municipio de Cali – ♀, Quebrada Honda, nr. Pichindé, 1800 m., XII.

*Ex Rhipidomys latimanus.* Depto. del Valle, Municipio de Cali – ♂, Valle del Río Pichindé, 1700 - 1900 m., VII; ♀, La Cumbre, Finca La María, 1500 m., XI.

*Remarks.* – *Polygenis thurmani* is now known from Perú and Colombia. The vertical distribution indicated by our material from southwestern Colombia fluctuates from 1450 meters to 1900 meters elevation. Our present information shows that in every one of these countries the hosts favored by *P. thurmani* are different. In Perú this flea has been taken from *Akodon pulcherrimus inambari, Phyllotis phaeus, Oryzomys stolzmanni* or *Oxymycteris p. nigrifrons.* Our Colombian specimens are from *Didelphis marsupialis, Oryzomys albigularis, Oryzomys* sp. (probably *O. caliginosus*), and *Rhipidomys latimanus.* The data on this species is still inadequate for drawing any conclusions on host preference. However, the premise that *Oryzomys albigularis* is the typical host might be reasonably founded on the basis of our collection: ten of 16 specimens of *P. thurmani* were found on this rodent.

### *Polygenis trapidoi,* new species
(Fig. 33, 34)

*Type material.* – Holotype ♂(HTC-1236) from *Oryzomys caliginosus,* Colombia, Depto. del Valle, Municipio de Cali, Valle del Río Pichindé, elevation 1700 - 1900 m, 31.X.1966, H. Trapido. Paratypes as follows: 1♂with same data as holotype: 1♂(HTC-1629) with other data as holotype but 31.III.1967, 1♂(HTC-1603), represented by mounted genitalia only, with same data as holotype but 17.III.1967; 1♂(00005), same host and locality but 21-25.I.1974, M. Thomas & L. Velásquez; 1♂(00007), same data as 00005, 1♂(00008), same data as (00005).

The holotype male is in the U.S. National Museum of Natural History. One paratype male is in the British Museum (Natural History) and the other paratype males remain in the Gorgas Memorial Laboratory's collection.

*Diagnosis.* – Near *P. dunni* Jordan & Rothschild from which it is separable by the subangular caudomarginal expansion of sternum VIII. Other diagnostic structures are contained in the genitalia illustrated.

*Description.* – Male. Head (Fig. 33A). Frontal tubercle not exserted. Micropores dispersed from area before falx to proximity of frontal tubercle. Preantennal row of 5 bristles, one near antenna longest. Preocular row with 3 prominent bristles and about equal number of minute bristles. Oral angle acuminate. Eye moderately pigmented, with profound ventral sinus. Tentorium well defined, with anterior stem strongly arched. Maxillary lobe acuminate, extended to 4th segment of maxillary palpus. Genal lobe definitely angular. Post antennal area with 3 rows of bristles and group of minute bristles close to antennal scape. Pronotum wide, its posterior margin extended beyond level of proepimeron.

Thorax. Pronotum and mesonotum each with 2 rows of bristles. Metanotum having 3 rows of bristles. Lateral metanotal area with 3 short anterior bristles followed by 2 large posterior bristles. Metepisternum with single bristle near pleural arch. Metepimeron with 6 bristles distributed in 2 rows.

Legs. Metatibia with 6 posteromarginal notches with strong bristles as follows: 2-2-2-3-2-3.

Modified abdominal segments (Fig. 33C). Tergum VIII small but extended to abdominal axis. Sternum VIII with posterior margin undulant but entire, with appreciably expanded subangular posterocaudal portion, having 10 bristles of diverse sizes oriented on mesal area. Fixed process of clasper (Fig. 33B) with subangular posterolateral elevation. Posterior margin of fixed process with angular prominence at about 0.25 of distance from top. Ventral margin notably undulate; distribution of bristles as illustrated. Movable process of clasper (Fig. 33B) elongate but not extended to apical portion of fixed process of clasper; barely wider on medial region with lateral margins slightly sinuate, with bristles scattered along margins and inner areas. Proximal arm of sternum IX (Fig. 33C) shorter than distal arm, constricted before bilobed apex. Distal arm of sternum IX (Fig. 34A) elongate, slightly curved upward, with numerous marginal and submarginal bristles of various sizes. Basal spur of sternum IX projected, with thick and highly sclerotized basal portion, provided with slender tendon. Distolateral lobes of terminal portion of aedeagus (Fig. 34B) somewhat falcate. Median dorsal lobe angular. Apico-median sclerite of aedeagus reduced and striated. Crochet indistinct. Lateral lobe wide, irregularly sinuated. Fender reduced and arched. Apical portion of inner tube slightly larger than basal portion of sclerotized inner tube, with coiled section of 2 or 3 loops, ended in free undulated portion directed upward. Basal portion of sclerotized inner tube compact, with most of superomarginal area straight, with very narrow foramen almost limited to anterior half but extended beyond mid point into fraction of posterior half. Ventral nodular section of this basal portion small. Ribs very numerous, on most of anterior section of terminal portion of aedeagus. Crescent sclerite sinuated, inconspicuous. Side pieces elongate, sinuous, with 2 opposite acuminate extremes. Lateroventral sclerite represented by curved knob-like structure with broad obtuse apex. Heel at base of aedeagal pouch semi-falcate, very prominent. Fluted membrane well developed.

Length. Holotype, 2.04 mm.

*Remarks.* — I take great pleasure in dedicating this species to Dr. Harold Trapido in appreciation for his kind collaboration and his contributions to the knowledge of ectoparasites.

## *Scolopsyllus colombianus* Méndez
(Fig. 35, 36)

*Scolopsyllus colombianus* Méndez, 1968, J. Med. Ent. 5:405-410, Fig. 1-14.

*Material examined.* — *Ex Oryzomys caliginosus.* Depto. del Valle, Municipio de Cali – ♂ holotype, ♀ allotype, Quebrada Honda, nr. Pichindé, 1800 m, IX; ♀ paratype, same locality, XII; 2♀ paratypes, Valle del Río Pichindé, 1700 - 1900 m., III, V.

*Ex Oryzomys alfaroi.* Depto. del Valle, Municipio de Cali – ♂ paratype, Valle del Río Pichindé, XI.

*Ex Didelphis marsupialis.* Depto. del Valle, Municipio de Cali – Pichindé, 1600 m., VIII.

*Remarks.* — *Scolopsyllus colombianus* is probably endemic to subtropical mountains of moderate elevations surrounding the Cauca Valley. The preferred host appears to be *Oryzomys caliginosus*, which is the most abundant and widespread rodent in the Departamento del Valle.

## *Rhopalopsyllus australis tupinus* Jordan & Rothschild
(Figure 37)

*Rhopalopsyllus australis tupinus* Jordan & Rothschild, 1923, Ectop., 1:328, Fig. 339.

*Material examined.* — *Ex Eira barbara.* Depto. del Valle, Municipio de Cali – ♂, Pichindé, VI.

*Remarks.* — Data gathered in Panamá (Tipton and Méndez, 1966) indicated that *R. australis tupinus* is normally found in association with the caviomorph rodent species *Dasyprocta punctata* and *Agouti paca*, which are the more selected hosts. The Collared Peccary, *Tayassu tajacu*, and the White-lipped Peccary, *Tayassu pecari*, follow those rodents in host preference. Other animals such as *Didelphis marsupialis, Chironectes minimus, Proechimys semispinosus* and other rodents, are also favored to a lower degree. Occasional hosts are carnivores like *Eira barbara, Galictis allamandi, Canis familiaris,* and others, that are infested by fleas obtained from their prey.

*Rhopallopsyllus australis tupinus* has not been previously reported from Colombia. We have also examined one male and five females from Carimangua, Departamento del Meta. This species is known from Panamá, Bolivia, Brazil and Perú. At least in Panamá, specimens of this taxon have been collected from sea level to elevations close to 1600 meters.

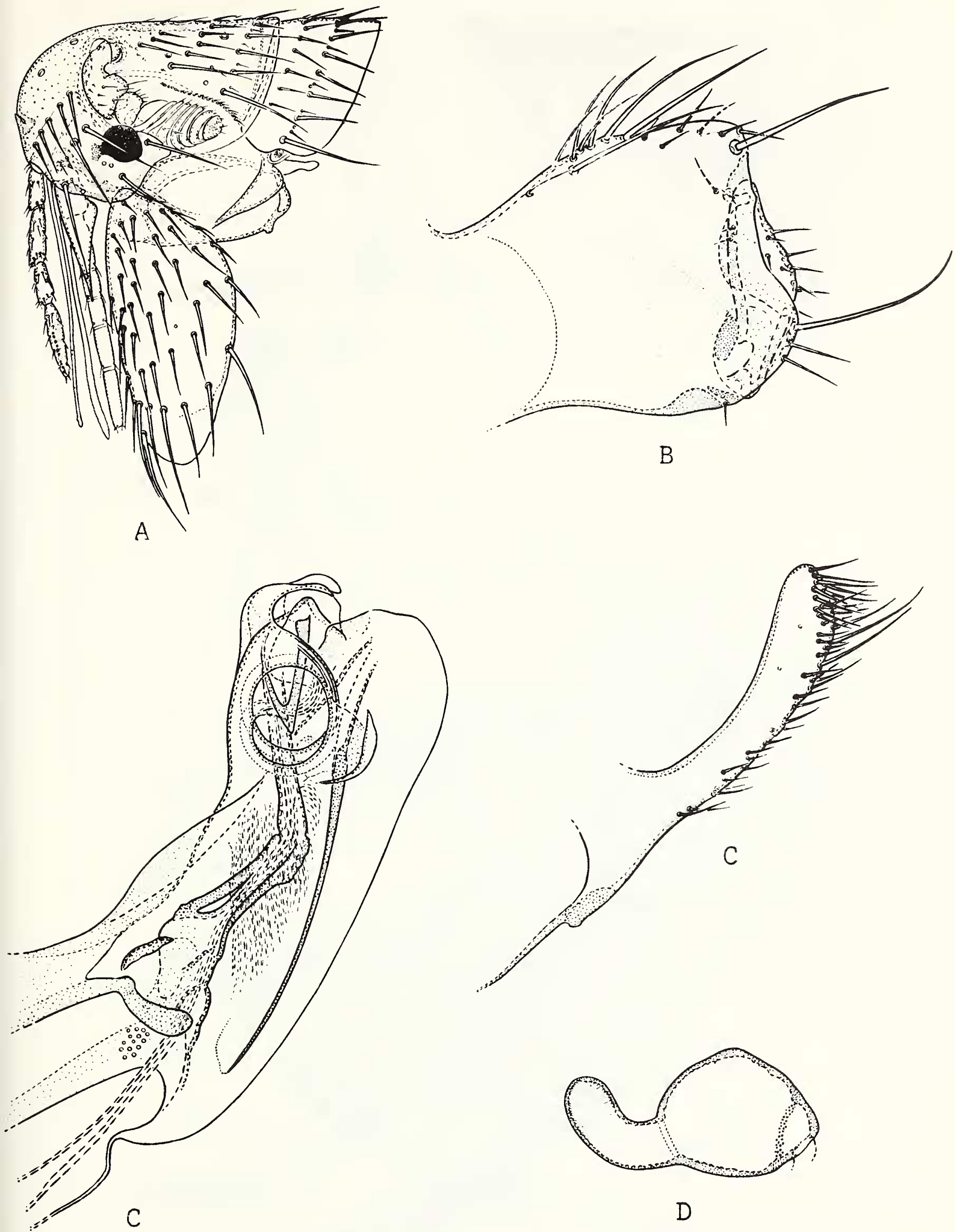


Fig. 20. *Polygenis bohlsi bohlsi* (Wagner). Male. A. Head, prothorax and procoxa; B. Process and movable finger of clasper; C. Apex of aedeagus. Female. D. Distal arm of 9th sternum; E. Spermatheca.

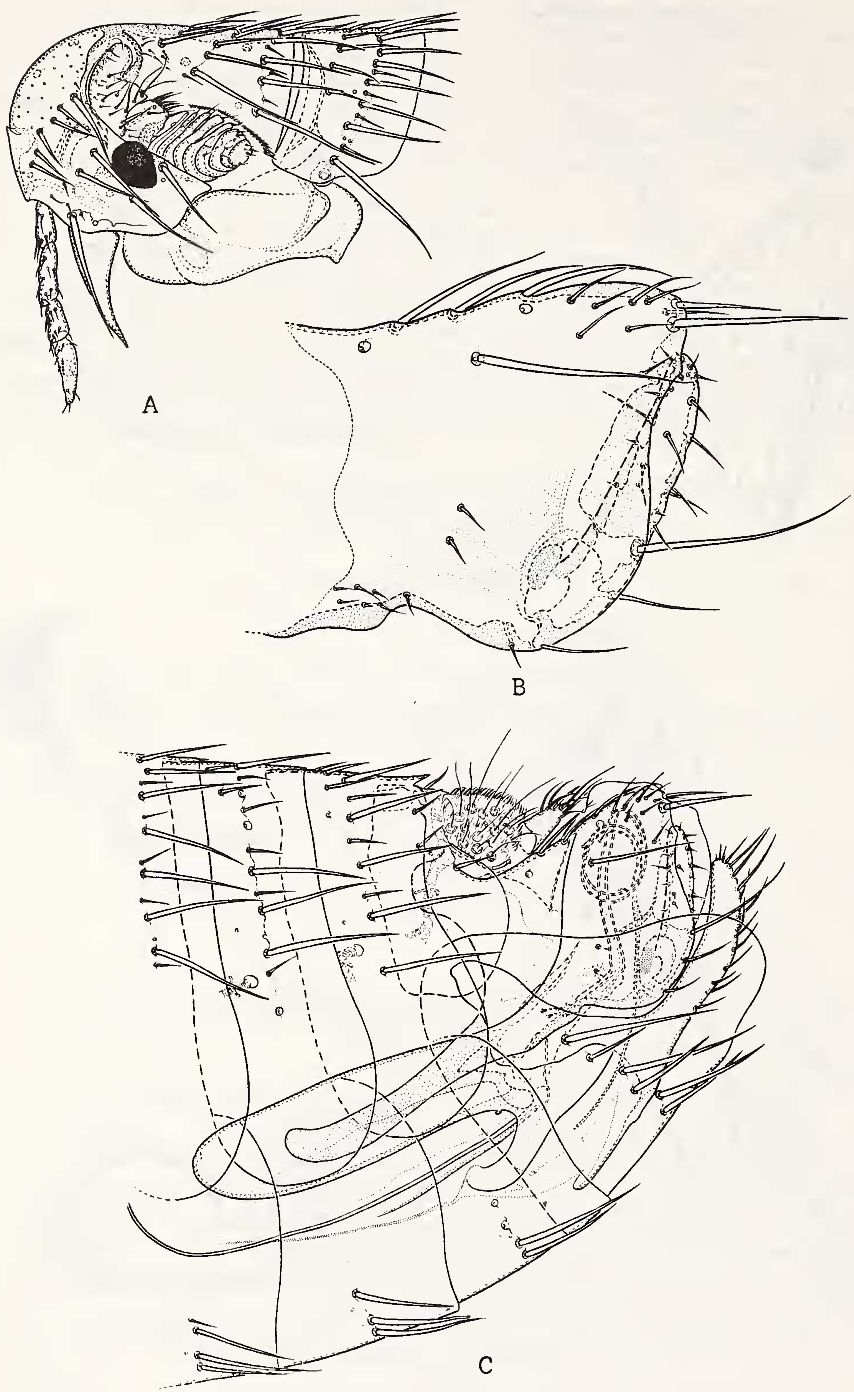


Fig. 21. *Polygenis caucensis,* n. sp. Male. A. Head and prothorax; B. Process and movable finger of clasper; C. Modified abdominal segments.

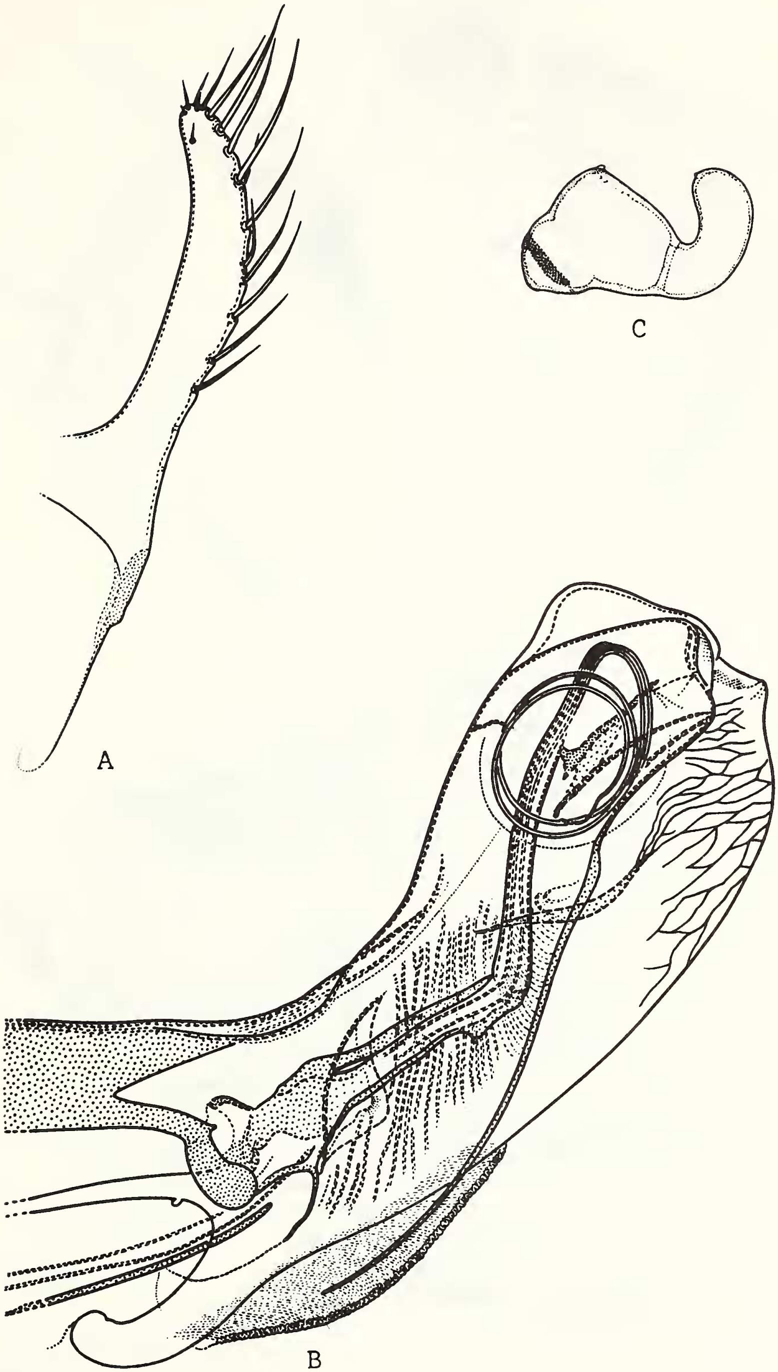


Fig. 22. *Polygenis caucensis*, n. sp. Male. A. Distal arm of 9th sternum; B. Apex of aedeagus. Female. C. Spermatheca.

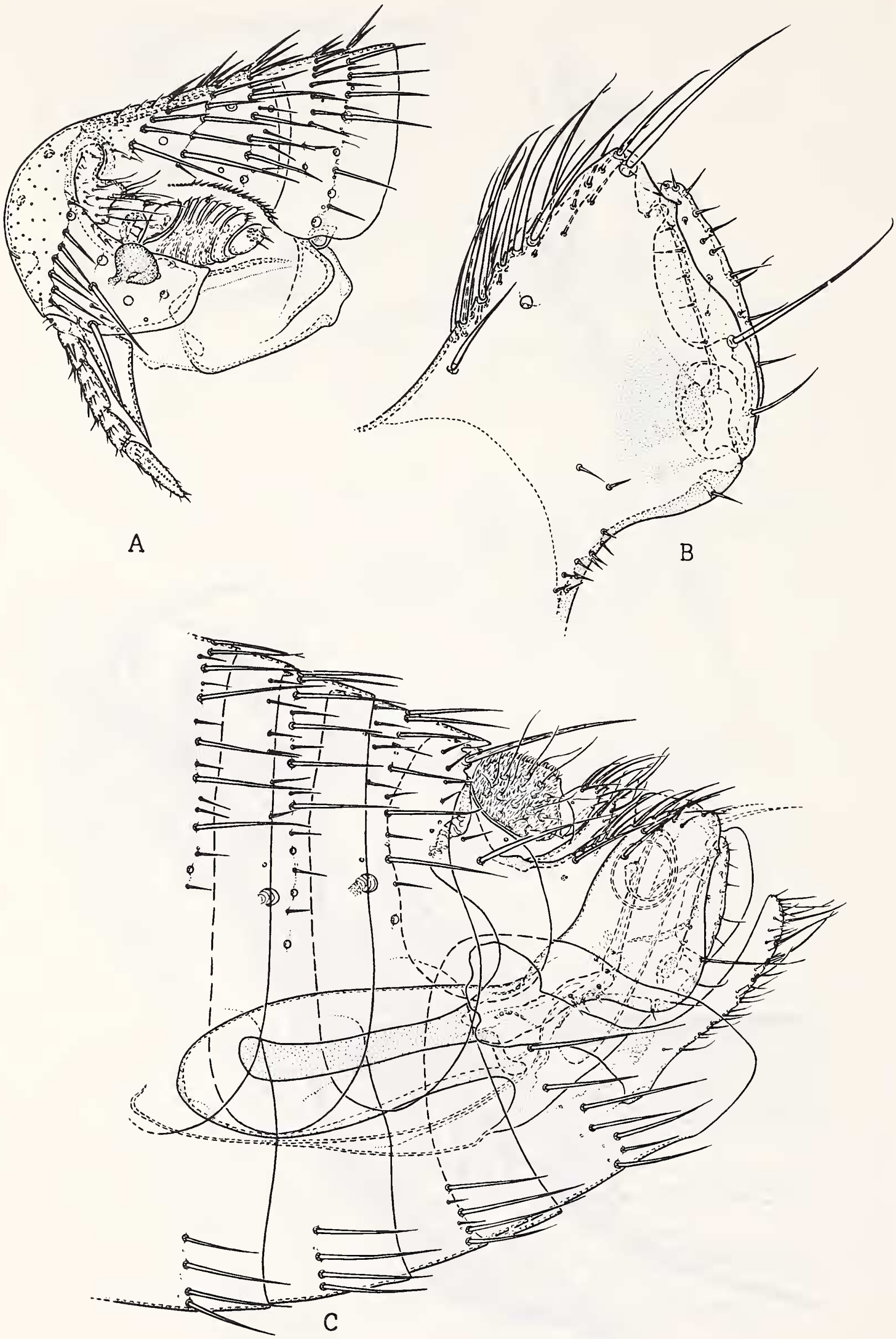


Fig. 23. *Polygenis delpontei,* n. sp. Male. A. Head and prothorax; B. Process and movable finger of clasper; C. Modified abdominal segments.

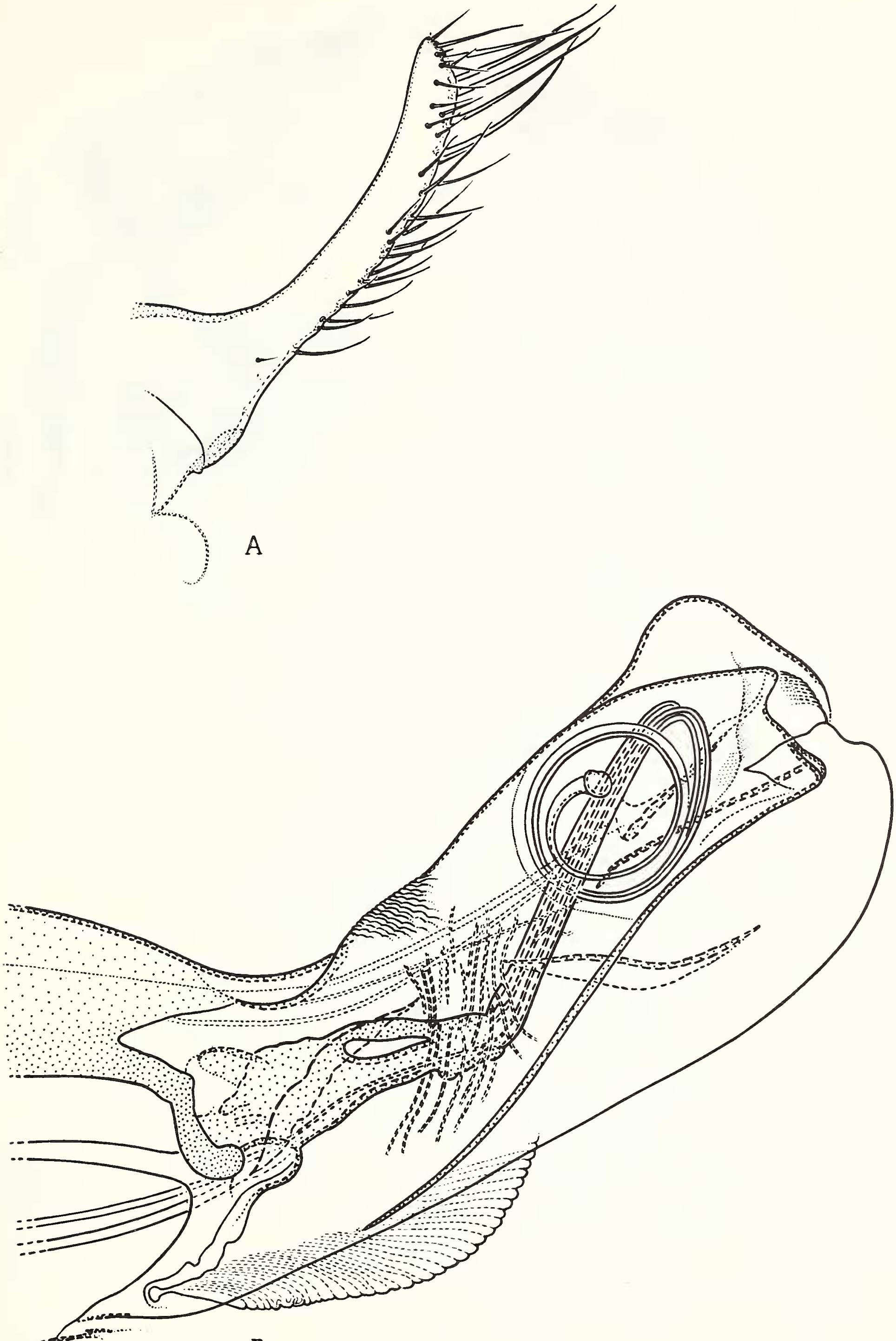


Fig. 24. *Polygenis delpontei,* n. sp. Male. A. Distal arm of 9th sternum; B. Apex of aedeagus.

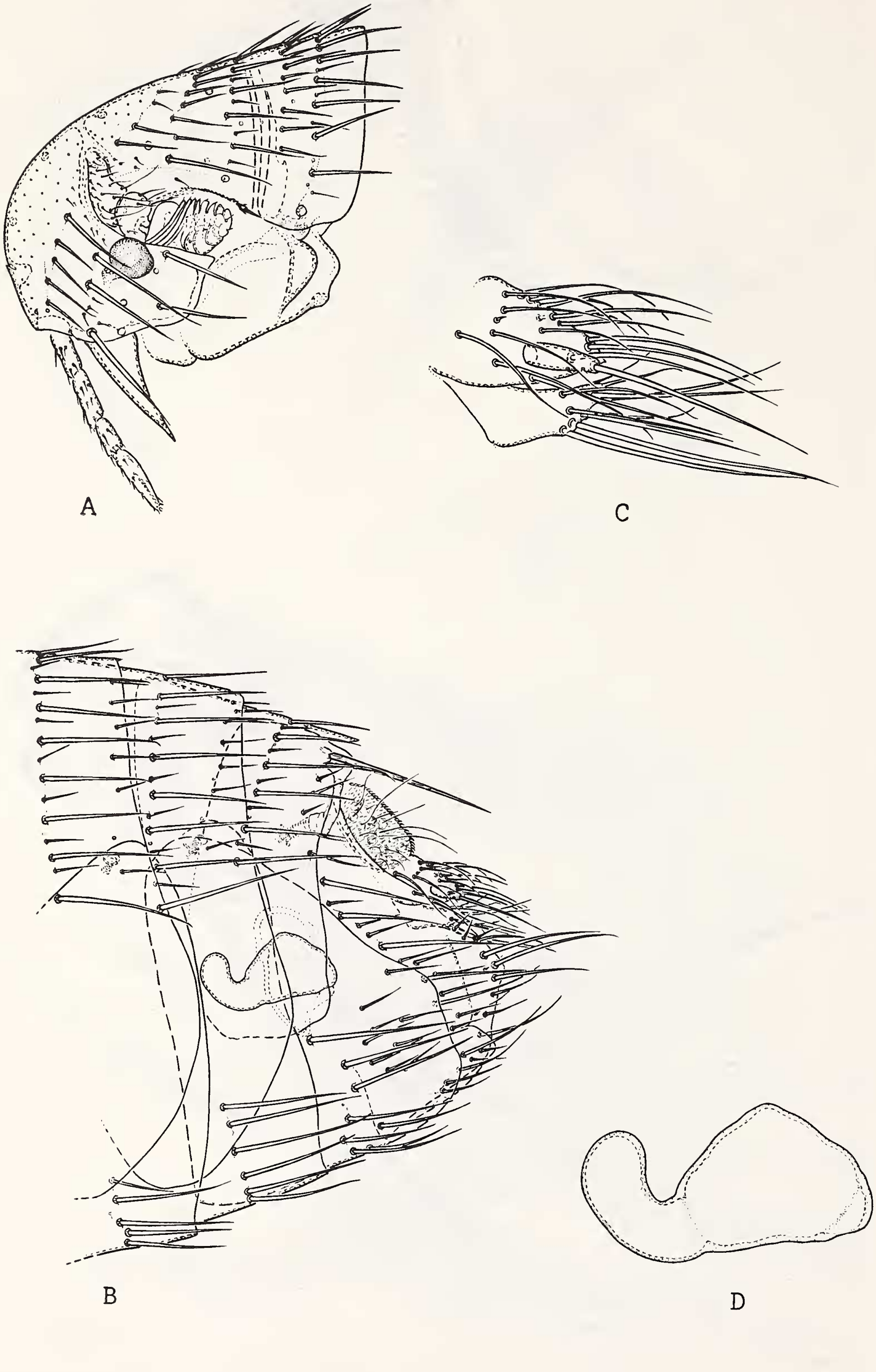

Fig. 25. *Polygenis delpontei,* n. sp. Female. A. Head and prothorax; B. Modified abdominal segments; C. Dorsal and anal lobes of proctiger; D. Spermatheca.


Fig. 26. *Polygenis dunni* (Jordan & Rothschild). Male. A. Head, prothorax and procoxa; B. Genitalia. Female. C. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

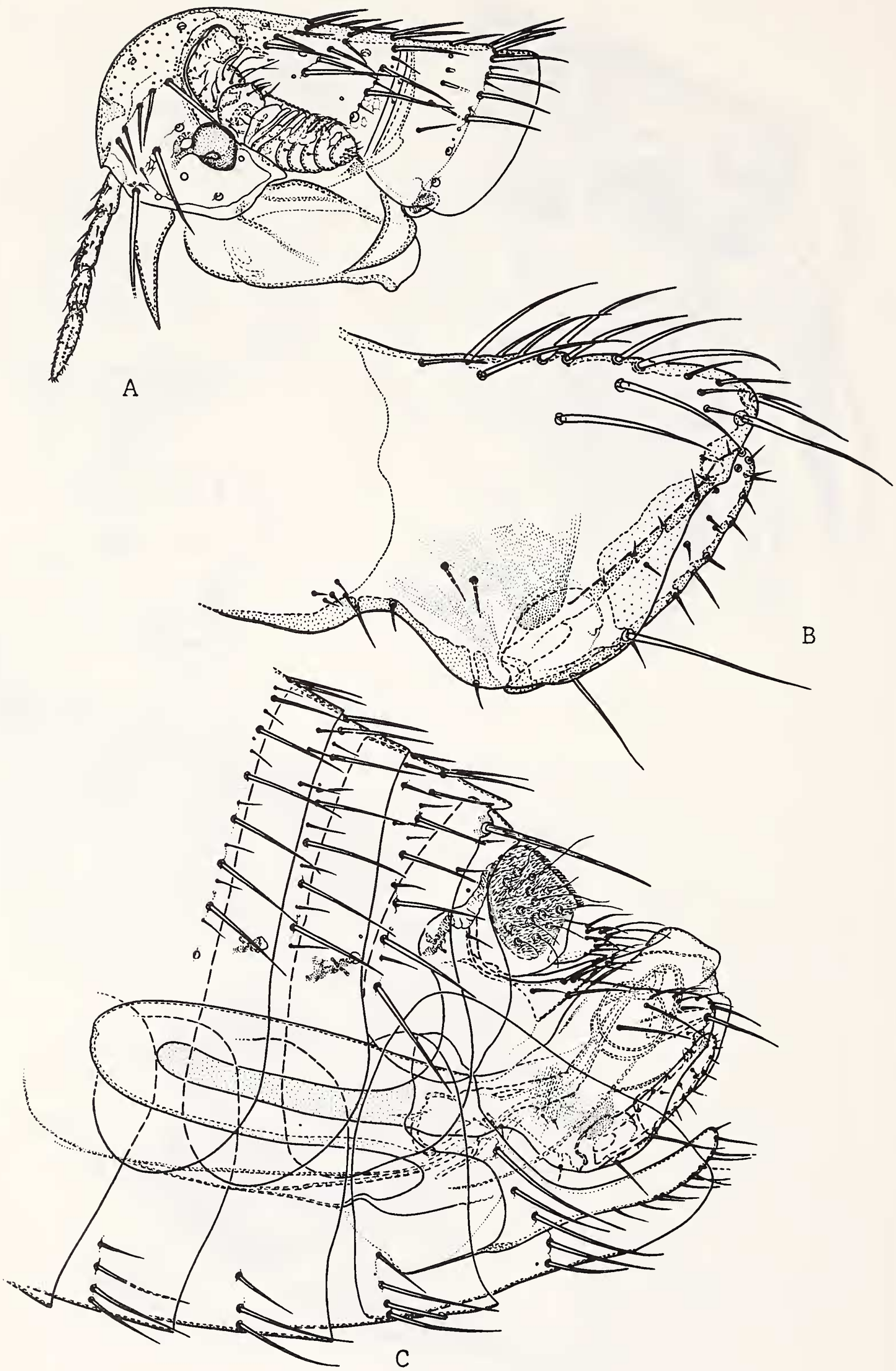


Fig. 27. *Polygenis hopkinsi,* n. sp. Male. A. Head and prothorax; B. Process and movable finger of clasper; C. Modified abdominal segments.

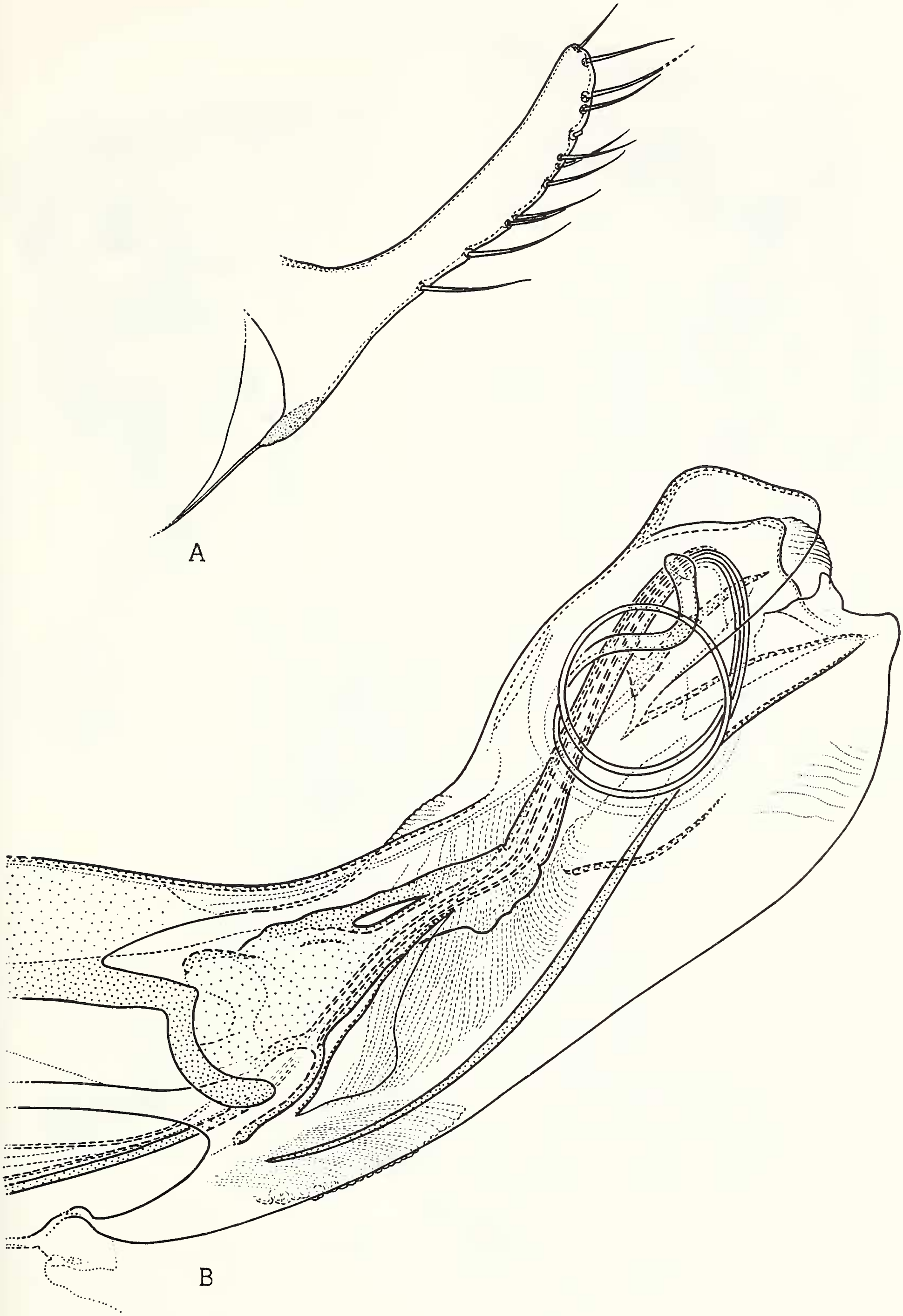


Fig. 28. *Polygenis hopkinsi*, n. sp. Male. A. Distal arm of 9th sternum; B. Apex of aedeagus.


Fig. 29. *Polygenis klagesi* (Rothschild). Male. A. Head, prothorax and procoxa; B. Genitalia. Female. C. Spermatheca and 7th abdominal segment.

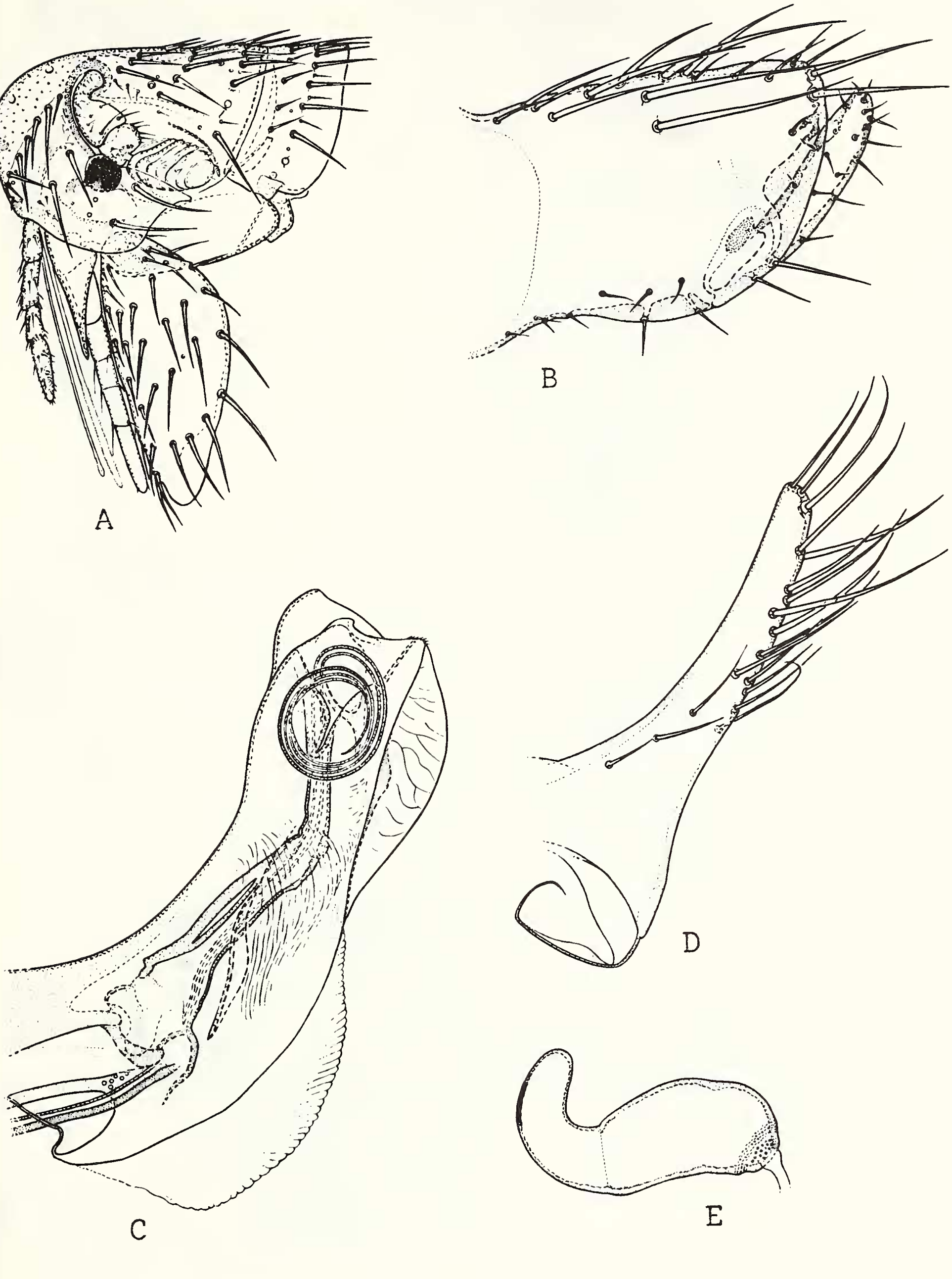


Fig. 30. *Polygenis pradoi* (Wagner). Male. A. Head, prothorax and procoxa; B. Process and movable finger of clasper; C. Apex of aedeagus; D. Distal arm of 9th sternum. Female. E. Spermatheca.


Fig. 31. *Polygenis roberti beebei* (I. Fox). Male. A. Head, prothorax and procoxa; B. Genitalia. Female. C. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).


Fig. 32. *Polygenis thurmani* Johnson. Male. A. Head, prothorax and procoxa; B. Process and movable finger of clasper; C. Apex of aedeagus; D. Distal arm of 9th sternum. Female. E. Spermatheca.

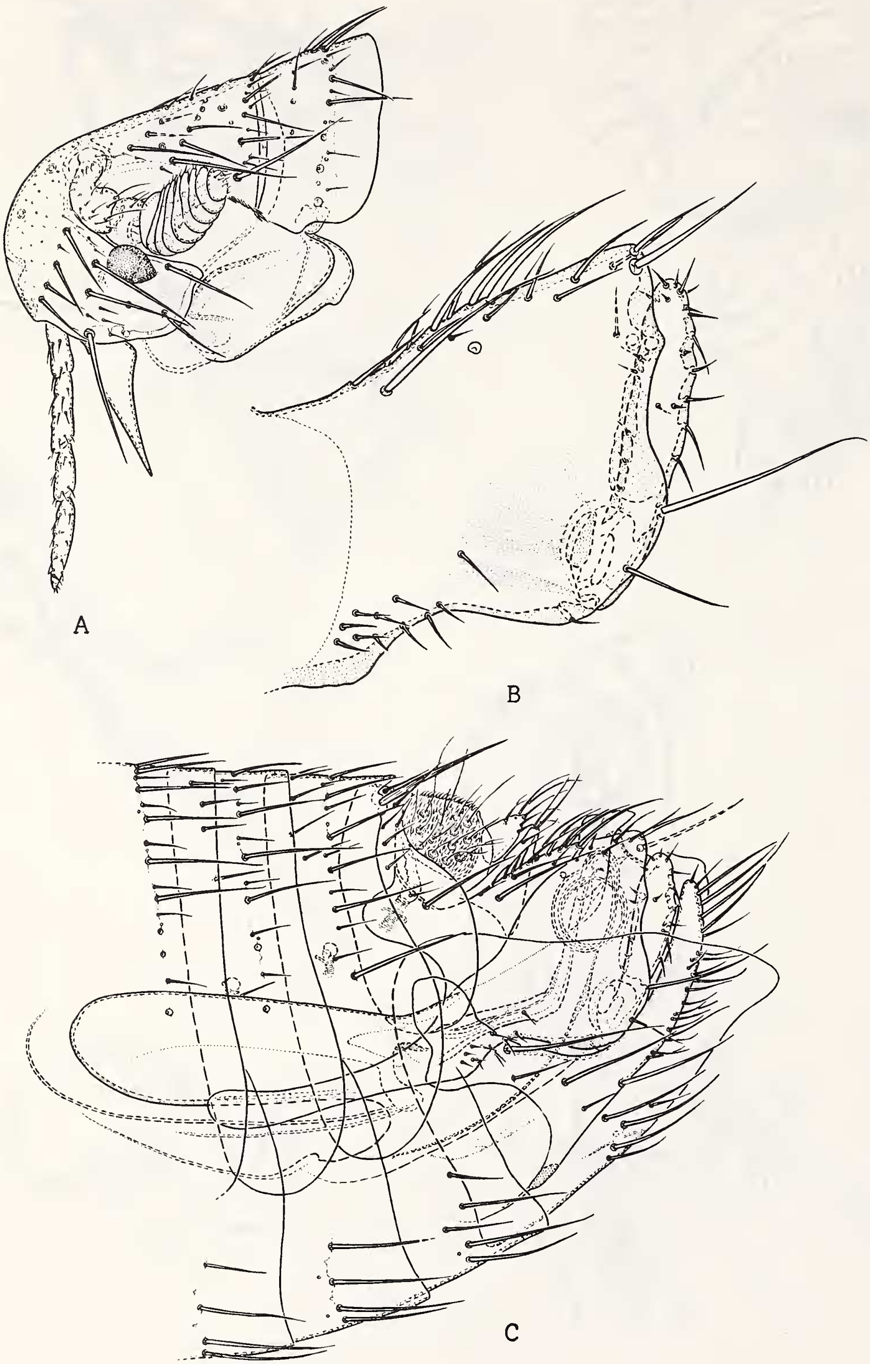


Fig. 33. *Polygenis trapidoi,* n. sp. Male. A. Head, prothorax and procoxa; B. Process and movable finger of clasper; C. Modified abdominal segments.

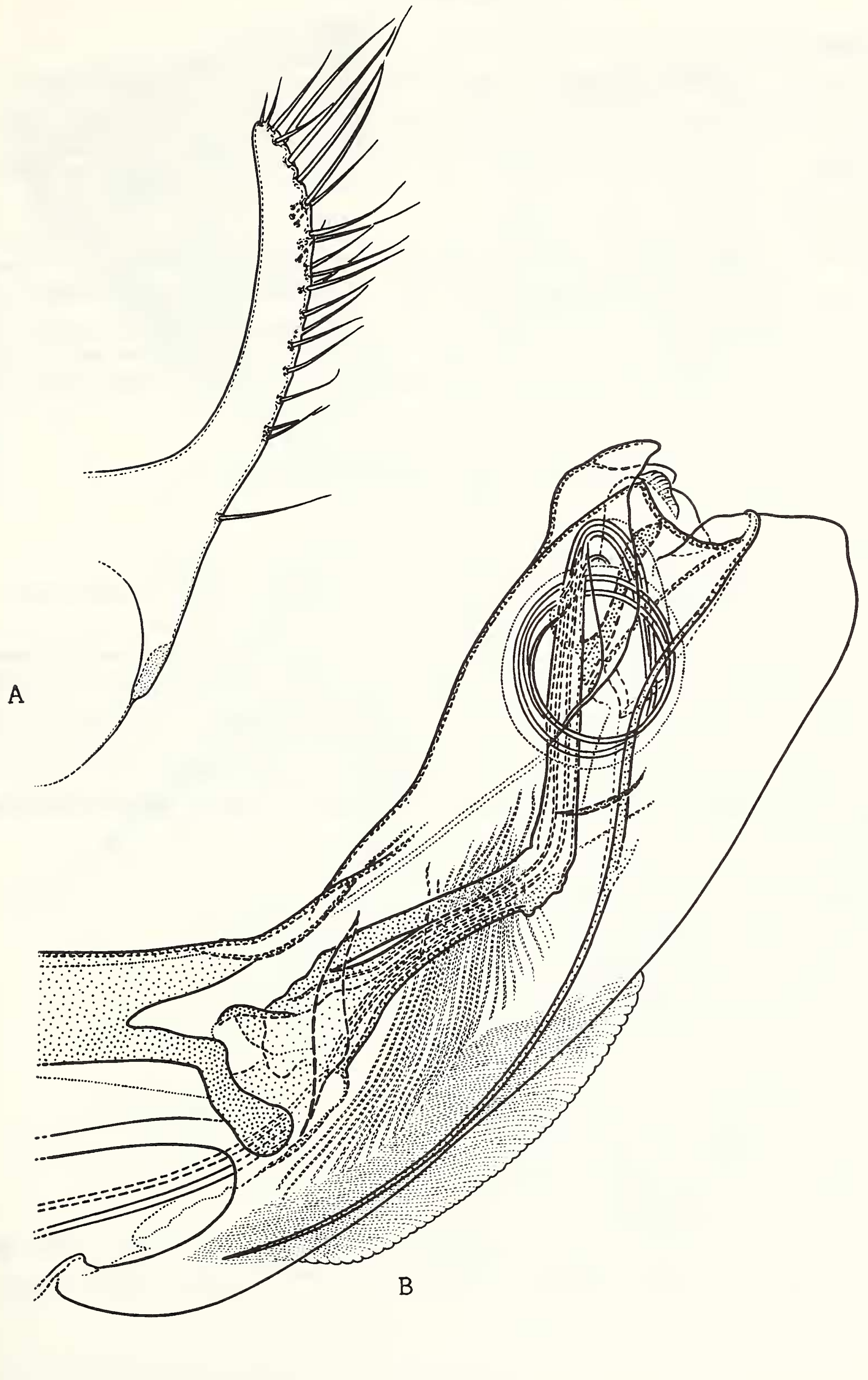


Fig. 34. *Polygenis trapidoi,* n. sp. Male. A. Distal arm of 9th sternum; B. Apex of aedeagus.

### *Rhopalopsyllus cacicus saevus* Jordan & Rothschild
(Figure 38)

*Rhopalopsyllus cacicus saevus,* 1923, Ectop., 1:325, Fig. 332.

*Remarks.* – I have not obtained specimens in the southwest part of Colombia; however, it seems reasonable to presume presence of this species in this territory since it is known from other areas of Colombia with similar ecological conditions and hosts. This form has been reported from this country by Fuller (1942) and I have examined specimens from Carimagua, Departamento del Meta.

So far *R. cacicus saevus* is known from Venezuela, Trinidad, Colombia, Panamá, Costa Rica, El Salvador, Guatemala and México. It is apparent that this flea has an affinity for *Dasypus novemcinctus* and *Didelphis marsupialis* throughout its geographical range; nevertheless, it is interesting to note that our series from Carimagua (12 males and 5 females) were entirely obtained from *Agouti paca.* In Panamá *Juxtapulex echidnophagoides* seems to replace *R. cacicus saevus* on its principal host, *Dasypus novemcinctus fenestratus* in areas of high elevations (Tipton and Méndez, 1967).

### *Rhopalopsyllus lugubris* Jordan & Rothschild
(Figure 39)

*Rhopalopsyllus lugubris* Jordan & Rothschild, 1908, Parasit., 1:74, P1. 3, Fig. 12; P1. 6, Fig. 9.

*Remarks.* – Although specimens of *R. lugubris* are lacking from our material from the southwest portion of Colombia, no doubt this flea occurs in this territory.

*Rhopalopsyllus lugubris* has been found in Panamá, Colombia, Brazil, Perú and Venezuela, parasitizing a miscellaneous group of hosts at low and moderate elevations. The strong preference of specimens for *Agouti paca* is shown in data presented by Tipton and Méndez (1967), and Tipton and Machado-Allison (1972). Our collection of Colombian fleas contains a lot of *R. lugubris* represented by 36 males and 70 females collected mainly from *Agouti paca* at Carimagua, Departamento del Meta. We assign these fleas to the form *R. lugubris cryptoctenes* (Enderlein).

## SUPERFAMILY PULICOIDEA
### FAMILY PULICIDAE
#### SUBFAMILY PULICINAE
##### TRIBE XENOPSYLLINI

### *Xenopsylla cheopis* (Rothschild)
(Figure 40)

*Pulex cheopis* Rothschild, 1903, Ent. Mon. Mag., 39:85, P1. 1, Fig. 3, 9; P1. 2, Fig. 12, 19.

*Material examined.* – *Ex Aletes fusciceps.* Depto. del Valle – 9♂, 12♀, Buenaventura, XI.
*Ex Oryzomys caliginosus.* Depto. del Valle, Municipio de Cali – ♀, Valle del Río Pichindé, 1700 m., VIII.
*Ex* "rat" (probably *Rattus norvegicus*). Depto. del Valle – ♀, vic. Cali, VII.
*Ex Rattus rattus.* Depto. del Valle – 3♂, 12♀, Acarology Barns.

*Remarks.* – *Xenopsylla cheopis* is a common parasite of commensal rats and is widely spread over the Asiatic, Ethiopian, Palaearctic, Neotropical and Australian Region. Many mammals have been found parasitized by this major vector of plague, but murids occupy first rank in host preference.

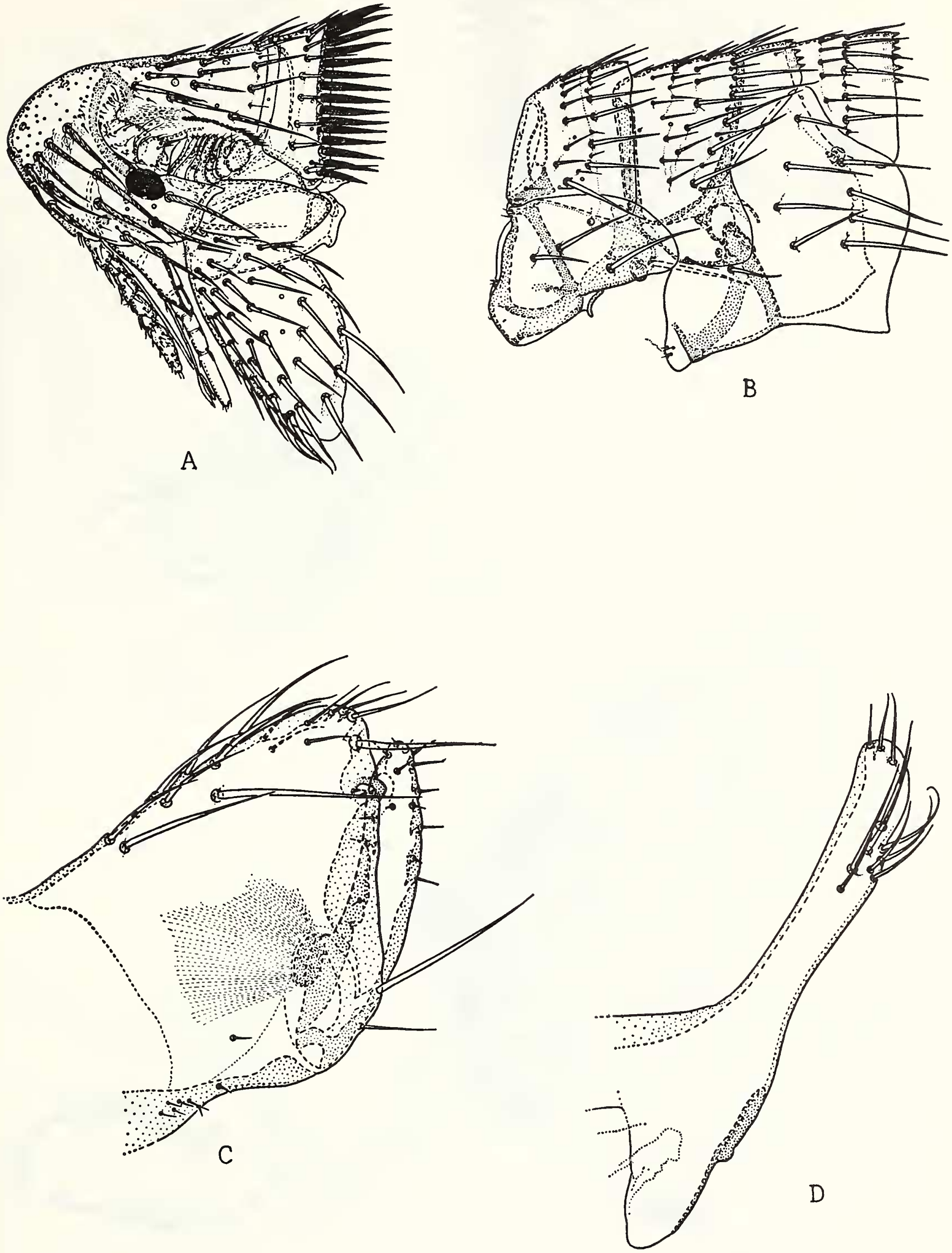


Fig. 35. *Scolopsyllus colombianus* Méndez. Male. A. Head, prothorax and procoxa; B. Mesothorax, metathorax and tergum I; C. Process and movable finger of clasper; D. Distal arm of 9th sternum.

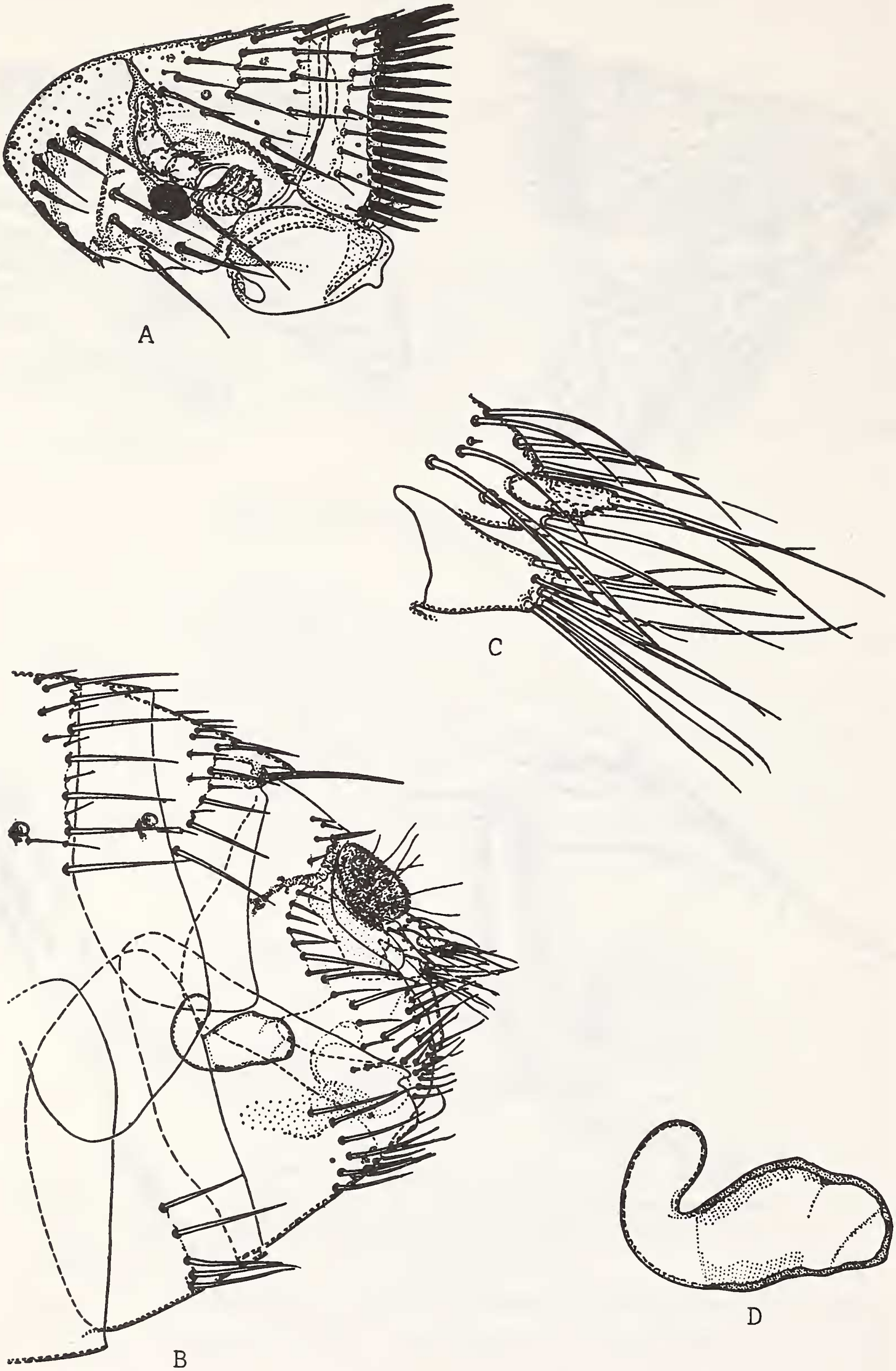


Fig. 36. *Scolopsyllus colombianus* Méndez. Female. A. Head and prothorax; B. Modified abdominal segments; C. Dorsal and anal lobes of proctiger; D. Spermatheca.

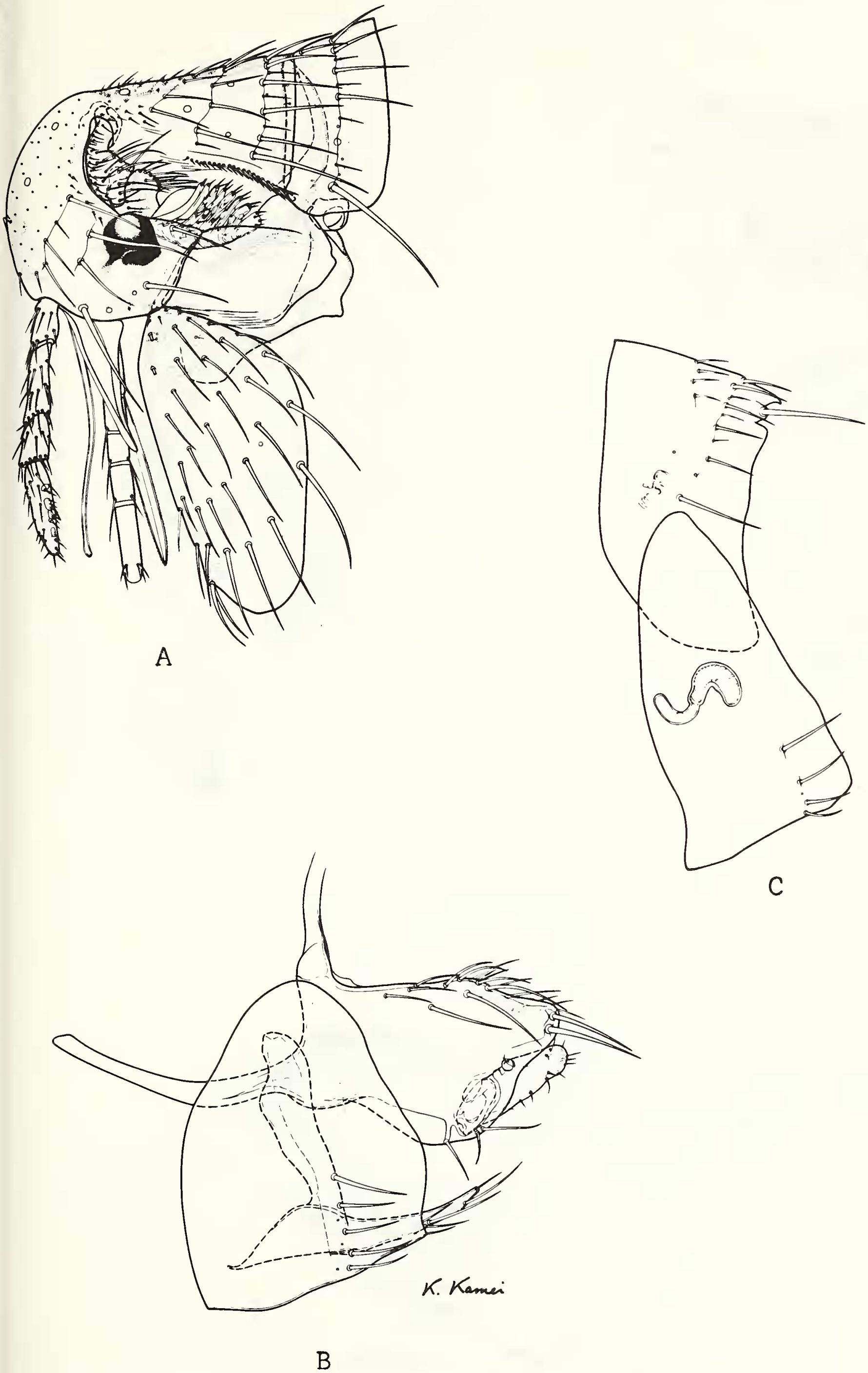


Fig. 37. *Rhopalopsyllus australis tupinus* Jordan & Rothschild. Male. A. Head, prothorax and procoxa; B. Genitalia. Female. C. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama", by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

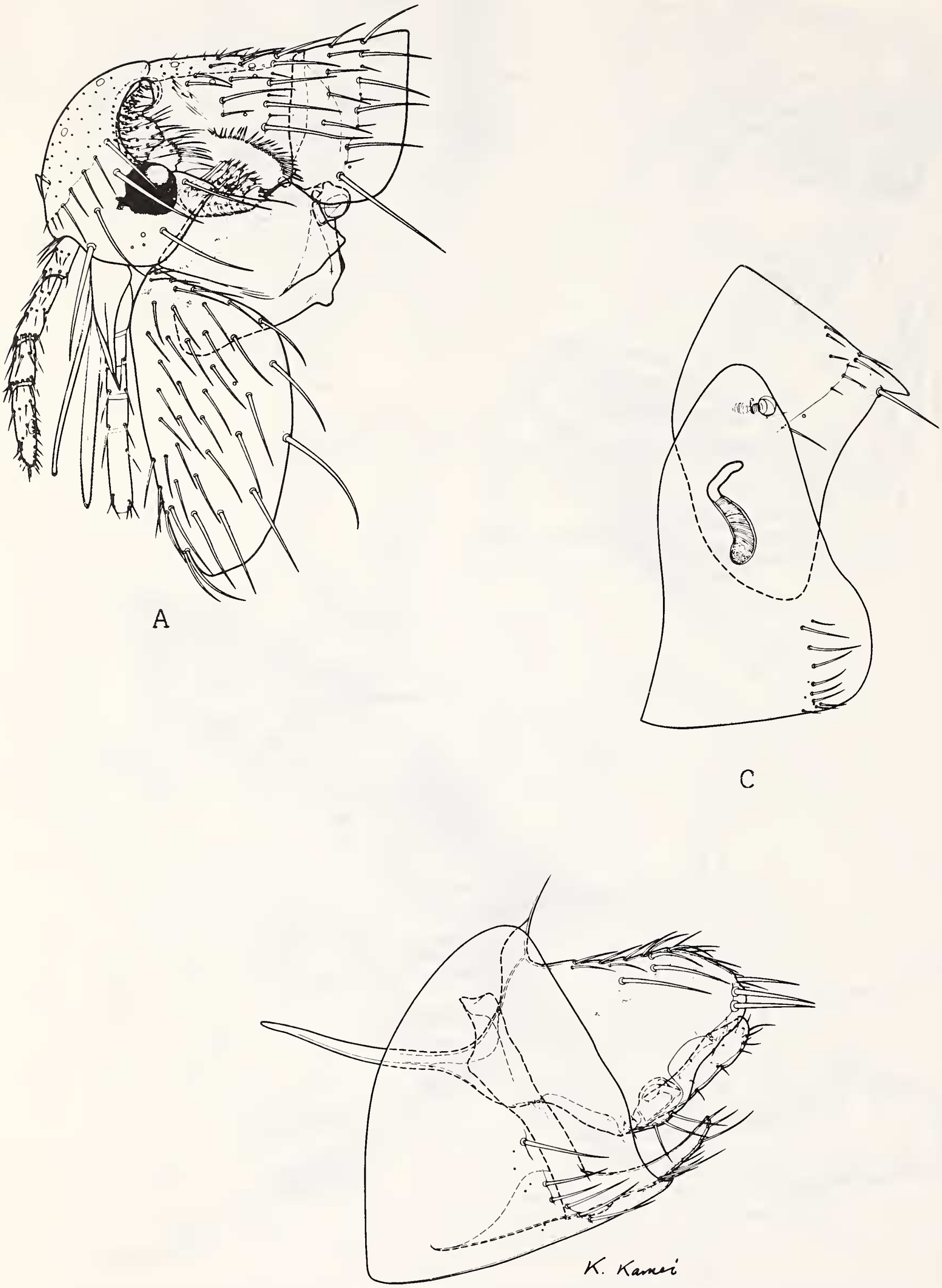


Fig. 38. *Rhopalopsyllus cacicus saevus* Jordan & Rothschild. Male. A. Head, prothorax and procoxa; B. Genitalia. Female. C. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

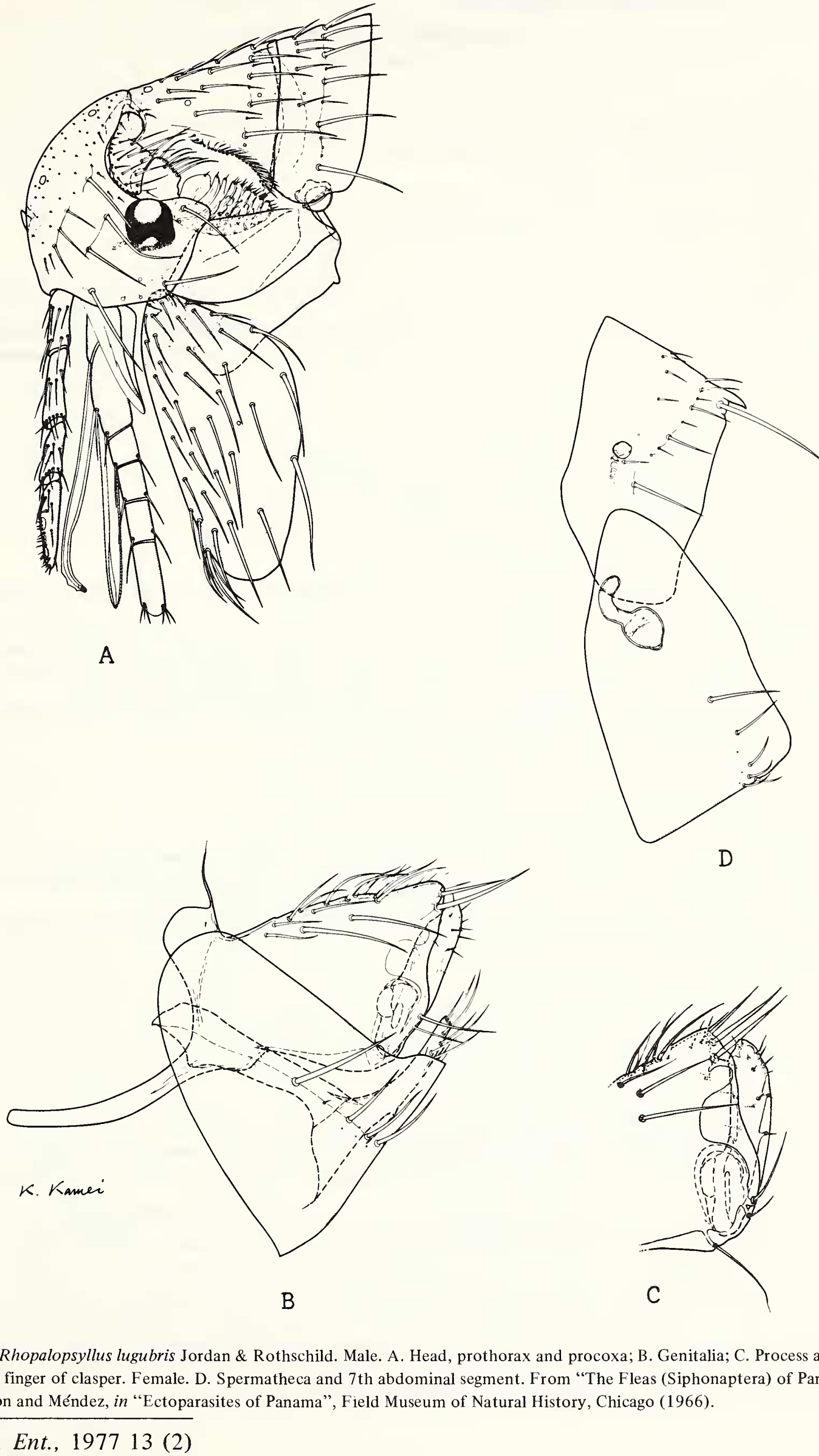


Fig. 39. *Rhopalopsyllus lugubris* Jordan & Rothschild. Male. A. Head, prothorax and procoxa; B. Genitalia; C. Process and movable finger of clasper. Female. D. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

TRIBE ARCHAEOPSYLLINI

*Ctenocephalides felis* (Bouché)
(Figure 41)

*Pulex felis* Bouché, 1835, Nova Acta Phys. Med. Acad. Caes. Leop. Carol. 17:505, Fig. 2.

*Material examined.* — *Ex Didelphis marsupialis.* Depto. del Valle, Municipio de Cali – 2♂, vic. Cali, VIII. Depto. del Valle, Municipio de Buga – 2♂, Sonso, VI.

*Ex Homo sapiens.* Depto. del Valle – ♂, ♀, Universidad Del Valle, V.

*Ex Oryzomys caliginosus.* Depto. del Valle – ♀, Lago Calima, 1450 m., II.

*Ex Felis catus.* Depto. del Valle – 2♂, ♀, XII.

*Ex Cerdocyon thous.* Depto. del Valle – ♂, Valle del Cauca, Yumbo - Palmesca Roadside, IX.

*Remarks.* — This species is almost cosmopolitan and has been reported from sea level to over 4000 meters elevation. It has been found on a wide range of hosts, including man; however, it is more specific on the domestic cat, *Felis (Felis) catus,* and secondarily on other carnivores.

TRIBE PULICINI

*Pulex irritans* Linnaeus
(Figure 42)

*Pulex irritans* Linnaeus, 1758, Syst. Nat., 10th ed.:614.

*Remarks.* — *Pulex irritans* is cosmopolitan and inhabits warm and temperate regions of the world. It has a wide host range and shows marked preference for various carnivores, man and certain ungulates. This species was reported from the Departamento del Valle by Renjifo (1944). Other Colombian records are given by Fuller (1942). *Pulex irritans* was considered the only flea (other than *X. cheopis*) of importance in Peruvian plague (Moll and O'Leary, 1945:168).

*Pulex simulans* Baker

*Pulex simulans* Baker, 1895, Can. Ent., 27:65, 67.

*Material examined.* — *Ex Thomasomys cineriventer.* Depto. de Nariño – ♀, Laguna de la Cocha, 2700 m., V.

*Remarks.* — This specimen represents the first record of *P. simulans* in Colombia. The geographical distribution of this species also includes Panamá, México, Venezuela and the United States of America.

SUBFAMILY TUNGINAE

*Rhynchopsyllus pulex* Haller
(Figure 43)

*Rhynchopsyllus pulex* Haller, 1880, Arch. Naturg., Jahrg. 46, Bd. 1:82, P1. 6, Fig. 1-13.

*Material examined.* — *Ex Molossus molossus major* (specimens). Depto. del Valle, Municipio de Cali – vic. Cali, VII. *Ex* guano of *Molossus molossus major.* Depto. del Valle, Municipio de Cali – 6♂ in attic of house, La Buitrera, ca. 10 km. S.W. Cali, 1100 m., IV.

*Ex Molossus molossus.* Depto. del Valle, Municipio de Cali – 2♀, Cali, inside house, IV; 4♀ Mayaguez, V.

*Ex Molossus molossus major,* or *Glossophaga soricina,* or *Desmodus rotundus.* Depto. del Valle, Municipio de Cali – 3♀, Site 1-A, vic. Cali, VIII.

*Ex Noctilio labialis.* Depto. del Valle, Municipio de Cali – 14♀, side of Rio Cauca, Pool NL3, III.

*Remarks.* — The known geographical range of *R. pulex* includes Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Perú, Venezuela, Panamá and Texas (southern United States). Inasmuch as this flea is a true parasite of bats, especially molossids, its distribution is probably correlated with that of its hosts.

Maurice Thomas kindly presented to us six male specimens of *Rhynchopsyllus* that he reared from guano of *Molossus molossus major* obtained at "La Buitrera". Comparisons with males of Panamanian *Rhynchopsyllus megastigmata*, indicate that they represent the same taxon. An evaluation of characters estimated as critical for separating females of *R. pulex* and *R. megastigmata* allowed us to observe that they are varied and therefore unreliable. We conclude that *Rhynchopsyllus megastigmata* Traub and Gammons, 1950, is conspecific with *Rhynchopsyllus pulex* Haller, 1880.

### *Tunga penetrans* (Linnaeus)
(Figure 44)

*Pulex penetrans* Linnaeus, 1758, Syst. Nat., 10th ed.:614.

*Remarks.* – *Tunga penetrans* is distributed in warm territories of the Neotropical and Ethiopian regions. This species is adapted to fixed parasitism and has been recovered from various hosts but displays high preference for *Sus scrofa* and *Homo sapiens.*

We have been unable to obtain specimens of this flea from southwestern Colombia; however, the chigoe was reported from the Departamento del Valle by Renjifo (1944). David E. Evans of Centro Internacional de Agricultura Tropical, has donated to us six specimens taken on *Sus scrofa* at Finca Lourdes, a locality in the Departamento de Cordoba.

## ANALYSIS OF HOST-PARASITE RELATIONSHIPS

Considerable information on host-parasite relationships of Neotropical fleas is presented by Johnson (1957) and Wenzel and Tipton (1966). Other publications dealing with this subject are Holland (1964), Hopkins (1957), Hopkins and Rothschild (1953, 1956, 1962, 1966, 1971), Lewis (1972, 1973, 1974 a, b, c, 1975), and Tipton and Méndez (1966). Brief comments on the flea taxa, considered herein, are derived from these and other sources, as well as my observations.

The available data concerning fleas of southwestern Colombia are not sufficient for an exhaustive analysis of zoogeography and host-parasite relationships. Additional collections that may contribute information on hosts, distribution and relative abundance, will be necessary to answer the remaining questions regarding the ecology of these parasites. Despite such disadvantages, some general preliminary assumptions and conclusions are presented on patterns of distribution and host-parasite associations.

In addition to the succeeding discussion, other data pertaining to host-parasite relationships are found in the taxonomic treatment and in Table 5.

The association of fleas to their hosts represents an important ecological event. Some flea species are characterized by strict specificity, while others display little or no preference. The fact that marked host specificity is not prevalent in the Siphonaptera, may indicate that this feature reduces the degree of their survival. The inability of very selective fleas to feed and reproduce on animals other than their own hosts, may be interpreted as a negative factor in maintaining a high reproductive potential.

On many occasions, some hosts such as bats, coexisting in a particular environment offer ideal situations for an interchange of promiscuous fleas. With relatively high frequency, predators accidentally harbor fleas that have likely strayed from their prey. It is also commonly observed that mammal or bird species may casually occupy burrows abandoned by other animals, and become infested with wandering fleas, usually of rodents, that have remained in such habitats. In such circumstances, the presence of these fleas on the animal may be purely accidental and the association can not be regarded as authentic.

Table 5. List of mammal hosts and their fleas[2]

| MAMMALS | FLEAS |
|---|---|
| Order Marsupialia | |
| Family Didelphidae | |
| *Chironectes minimus* | *Adoratopsylla (T.) intermedia copha* |
| *Didelphis azarae* | *Neotyphloceras rosenbergi* |
| | *Adoratopsylla (T.) intermedia copha* |
| *Didelphis marsupialis* | *Neotyphloceras rosenbergi* |
| | *Polygenis thurmani* |
| | *Scolopsyllus colombianus* |
| | *Ctenocephalides felis* |
| *Metachirus nudicaudatus* | *Adoratopsylla (T.) intermedia copha* |
| *Philander opossum* | *Adoratopsylla (T.) intermedia copha* |
| Family Caenolestidae | |
| *Caenolestes obscurus* | *Ctenidiosomus traubi* |
| | *Sphinctopsylla diomedes* |
| | *Plocopsylla phyllisae* |
| | *Pleochaetis smiti* |
| | *Tetrapsyllus comis* |
| Order Chiroptera | |
| Family Noctilionidae | |
| *Noctilio labialis* | *Rhynchopsyllus pulex* |
| Family Phyllostomatidae | |
| *Glossophaga soricina* | *Rhynchopsyllus pulex* |
| Family Desmodontidae | |
| *Desmodus rotundus* | *Rhynchopsyllus pulex* |
| Family Molossidae | |
| *Molossus molossus major* | *Rhynchopsyllus pulex* |
| *Tadarida* sp. | *Sternopsylla distincta speciosa* |
| Order Primates | |
| Family Cebidae | |
| *Ateles fusciceps* | *Xenopsylla cheopis* |
| Family Hominidae | |
| *Homo sapiens* | *Ctenocephalides felis* |
| | *Pulex irritans* |
| | *Tunga penetrans* |
| Order Rodentia | |
| Family Sciuridae | |
| *Sciurus granatensis* | *Neotyphloceras rosenbergi* |
| Family Heteromyidae | |
| *Heteromys australis* | *Polygenis bohlsi bohlsi* |
| Family Cricetidae | |
| *Oryzomys (Oligoryzomys)* sp. | *Neotyphloceras rosenbergi* |
| *Oryzomys (Oryzomys) albigularis* | *Neotyphloceras rosenbergi* |
| | *Ctenidiosomus rex* |
| | *Cleopsylla monticola* |
| | *Plocopsylla thor* |
| | *Pleochaetis smiti* |
| | *Polygenis bohlsi bohlsi* |
| | *Polygenis hopkinsi* |
| | *Polygenis pardoi* |
| | *Polygenis thurmani* |
| *Oryzomys (Oryzomys) alfaroi* | *Neotyphloceras rosenbergi* |
| | *Polygenis bohlsi bohlsi* |
| | *Scolopsyllus colombianus* |
| *Oryzomys (Melanomys) caliginosus* | *Neotyphloceras rosenbergi* |
| | *Polygenis bohlsi bohlsi* |
| | *Polygenis delpontei*, n. sp. |
| | *Polygenis caucensis*, n. sp. |
| | *Polygenis pradoi* |
| | *Polygenis thurmani* |
| *Oryzomys (Melanomys) caliginosus* (con't) | *Polygenis trapidoi*, n. sp. |
| | *Scolopsyllus colombianus* |
| | *Xenopsylla cheopis* |
| | *Ctenocephalides felis* |
| *Rhipidomys latimanus* | *Neotyphloceras rosenbergi* |
| | *Leptopsylla segnis* |
| | *Polygenis thurmani* |
| | *Polygenis pradoi* |
| *Rhipidomys similis* | *Neotyphloceras rosenbergi* |
| | *Cleopsylla monticola* |
| *Thomasomys aureus* | *Neotyphloceras rosenbergi* |
| | *Ctenidiosomus traubi* |
| *Thomasomys cinereiventer* | *Neotyphloceras rosenbergi* |
| | *Ctenidiosomus traubi* |
| | *Cleopsylla monticola* |
| | *Sphinctopsylla tolmera* |
| | *Plocopsylla thor* |
| | *Dasypsyllus gallinulae perpinnatus* |
| | *Pleochaetis equatoris equatoris* |
| | *Pleochaetis smiti* |
| | *Pulex simulans* |
| *Thomasomys fuscatus* | *Neotyphloceras rosenbergi* |
| | *Adoratopsylla intermedia copha* |
| | *Cleopsylla monticola* |
| | *Polygenis bohlsi bohlsi* |
| | *Polygenis delpontei* |
| | *Polygenis pradoi* |
| *Thomasomys* sp. | *Neotyphloceras rosenbergi* |
| | *Ctenidiosomus rex* |
| | *Cleopsylla monticola* |
| | *Sphinctopsylla tolmera* |
| | *Plocopsylla thor* |
| Family Muridae | |
| *Rattus norvegicus* | *Xenopsylla cheopis* |
| *Rattus rattus* | *Leptopsylla segnis* |
| | *Xenopsylla cheopis* |
| Family Dasyproctidae | |
| *Agouti paca* | *Rhopalopsyllus australis tupinus* |
| | *Rhopalopsyllus cacicus saevus* |
| | *Rhopalopsyllus lugubris* |
| *Dasyprocta punctata* | *Rhopalopsyllus australis tupinus* |
| | *Rhopalopsyllus cacicus saevus* |
| | *Rhopalopsyllus lugubris* |
| Family Echimyidae | |
| *Proechimys semispinosus* | *Polygenis klagesi* |
| *Hoplomys gymnurus* | *Polygenis klagesi* |
| Order Carnivora | |
| Family Canidae | |
| *Canis familiaris* | *Ctenocephalides felis* |
| *Urocyon cinereoargenteus* | *Ctenocephalides felis* |
| *Cerdocyon thous* | *Ctenocephalides felis* |
| Family Mustelidae | |
| *Eira barbara* | *Rhopalopsyllus australis tupinus* |
| *Mustela frenata* | *Neotyphloceras rosenbergi* |
| Family Felidae | |
| *Felis (Felis) catus* | *Ctenocephalides felis* |

2. This list is based on original information and records from southwestern Colombia present in the literature. The mammal taxa sequence follows the classification provided by Simpson (1945).

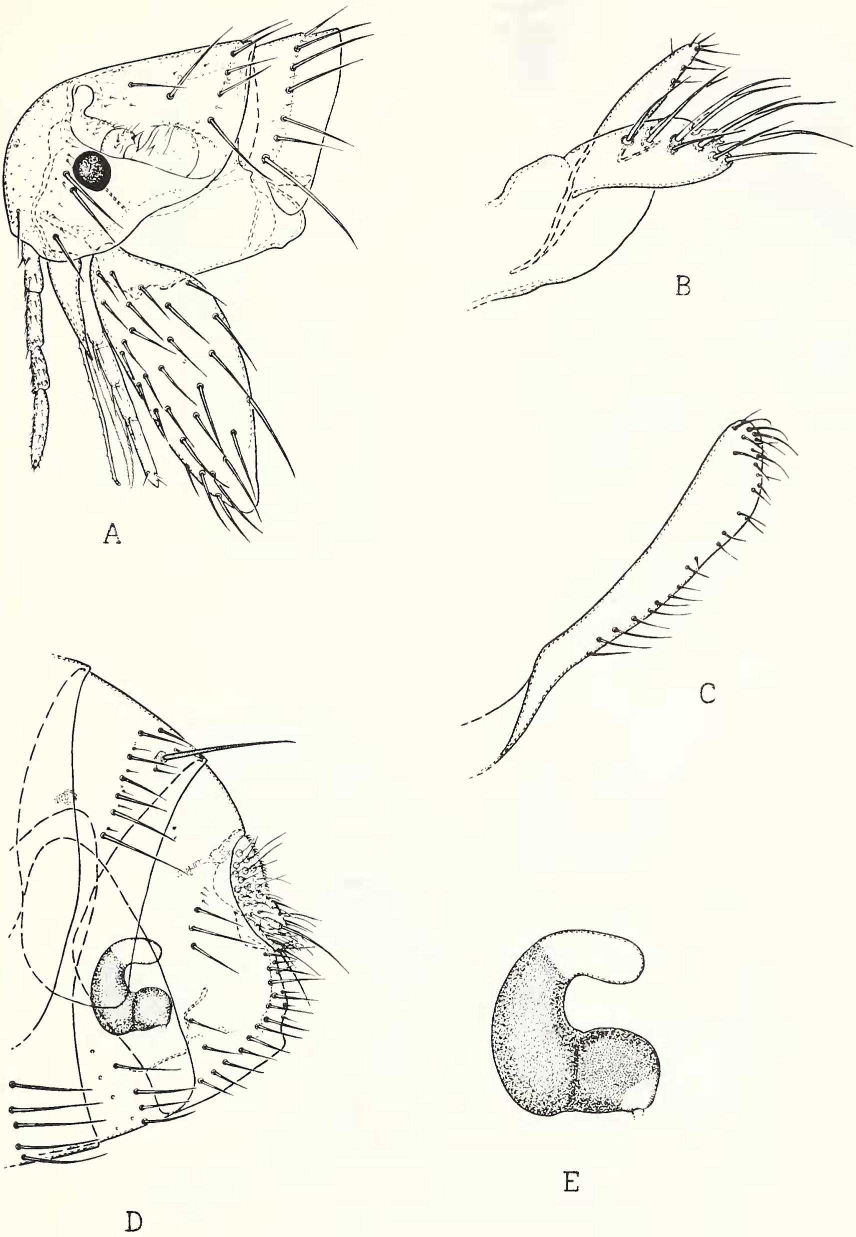


Fig. 40. *Xenopsylla cheopis* (Rothschild). Male. A. Head, prothorax and procoxa; B. Process and movable finger of clasper; C. Distal arm of 9th sternum. Female. D. Modified abdominal segments; E. Spermatheca.

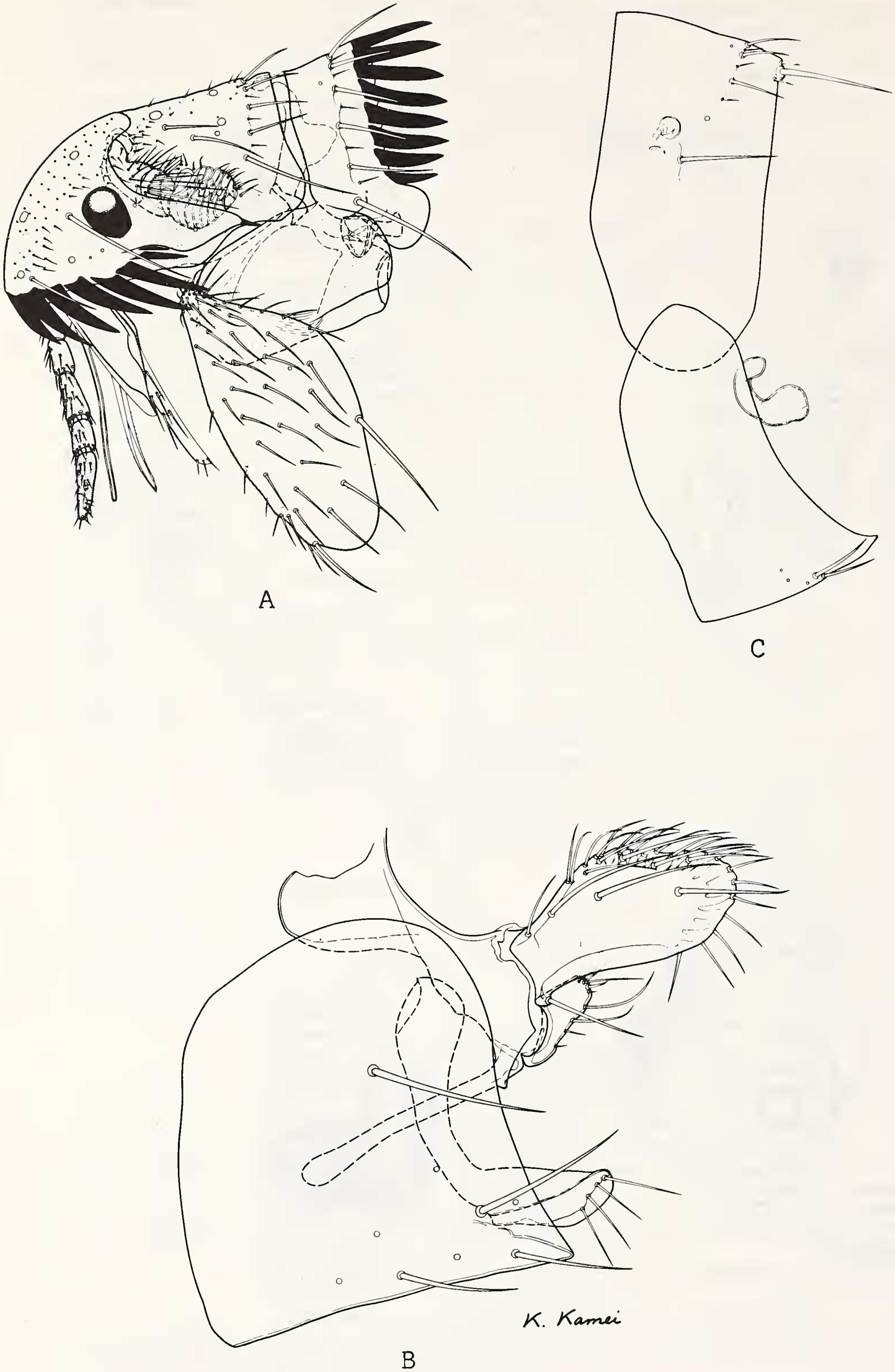


Fig. 41. *Ctenocephalides felis* (Bouché). Male. A. Head, prothorax and procoxa; B. Genitalia. Female. C. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

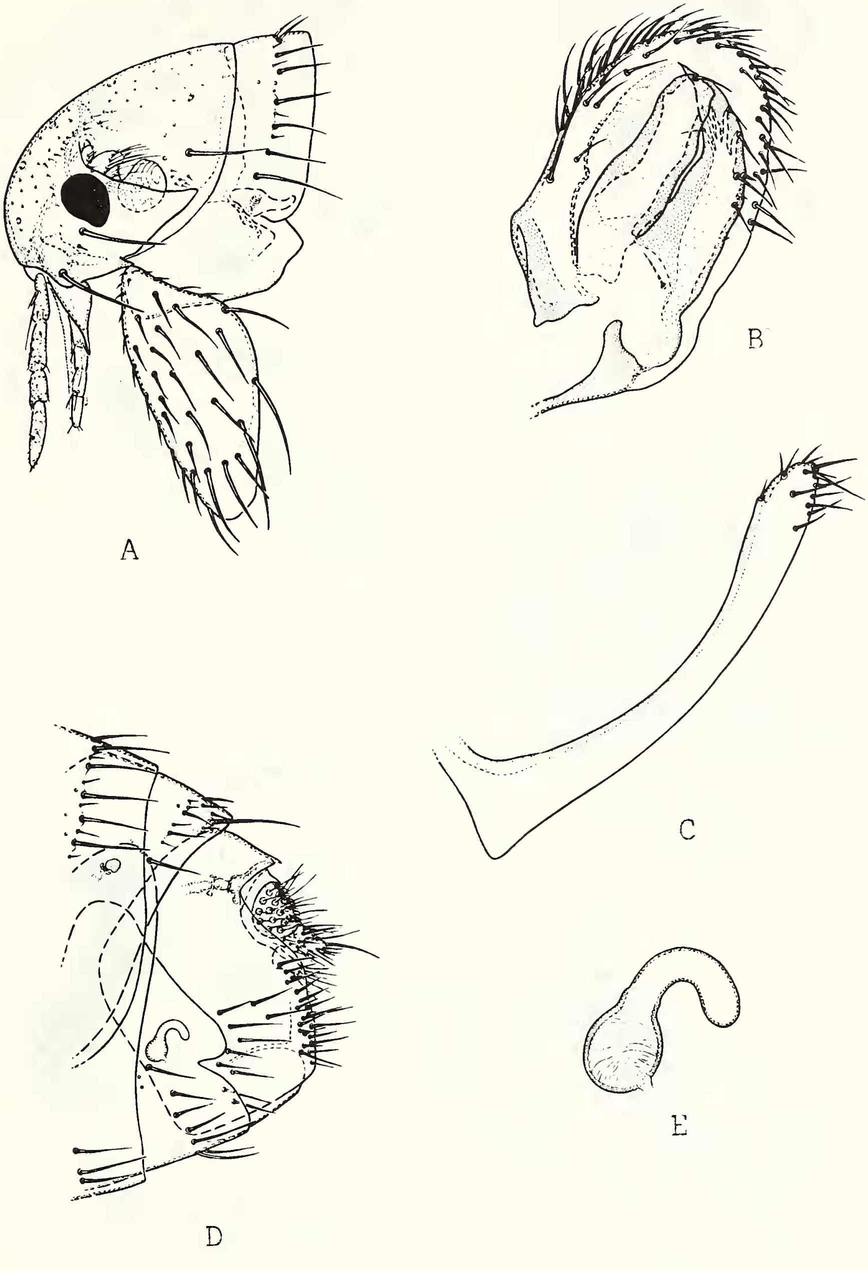


Fig. 42. *Pulex irritans* Linnaeus. Male. A. Head, prothorax and procoxa; B. Detached process and movable finger of clasper; C. Distal arm of 9th sternum. Female. D. Modified abdominal segments; E. Spermatheca.

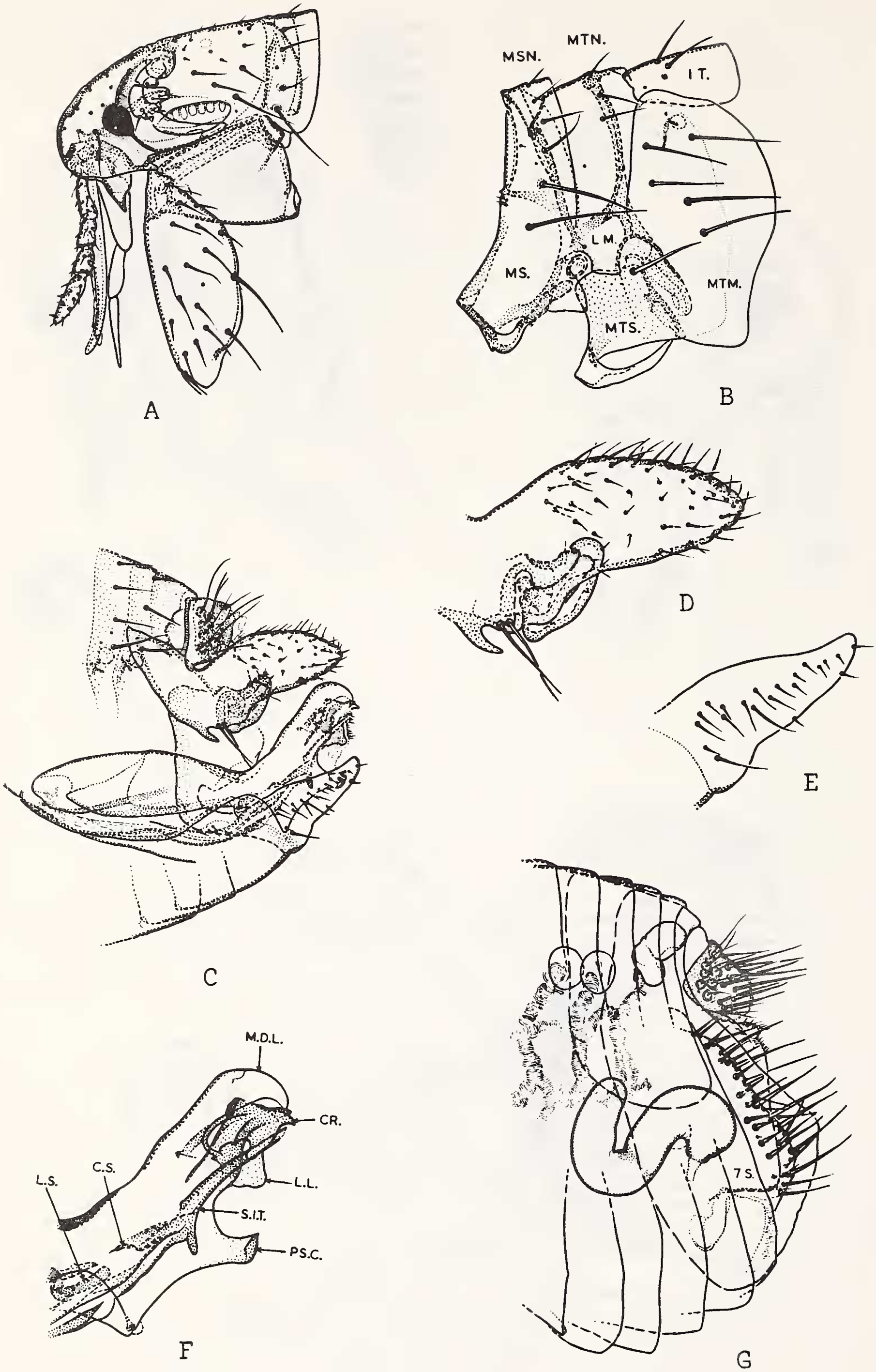


Fig. 43. *Rhynchopsyllus pulex* Haller. Male. A. Head, prothorax and procoxa; B. Mesothorax, metathorax and 1st abdominal segment; C. Modified abdominal segments; D. Process and movable finger of clasper; E. Distal arm of 9th sternum; F. Apex of aedeagus. Female. G. Spermatheca and modified abdominal segments. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

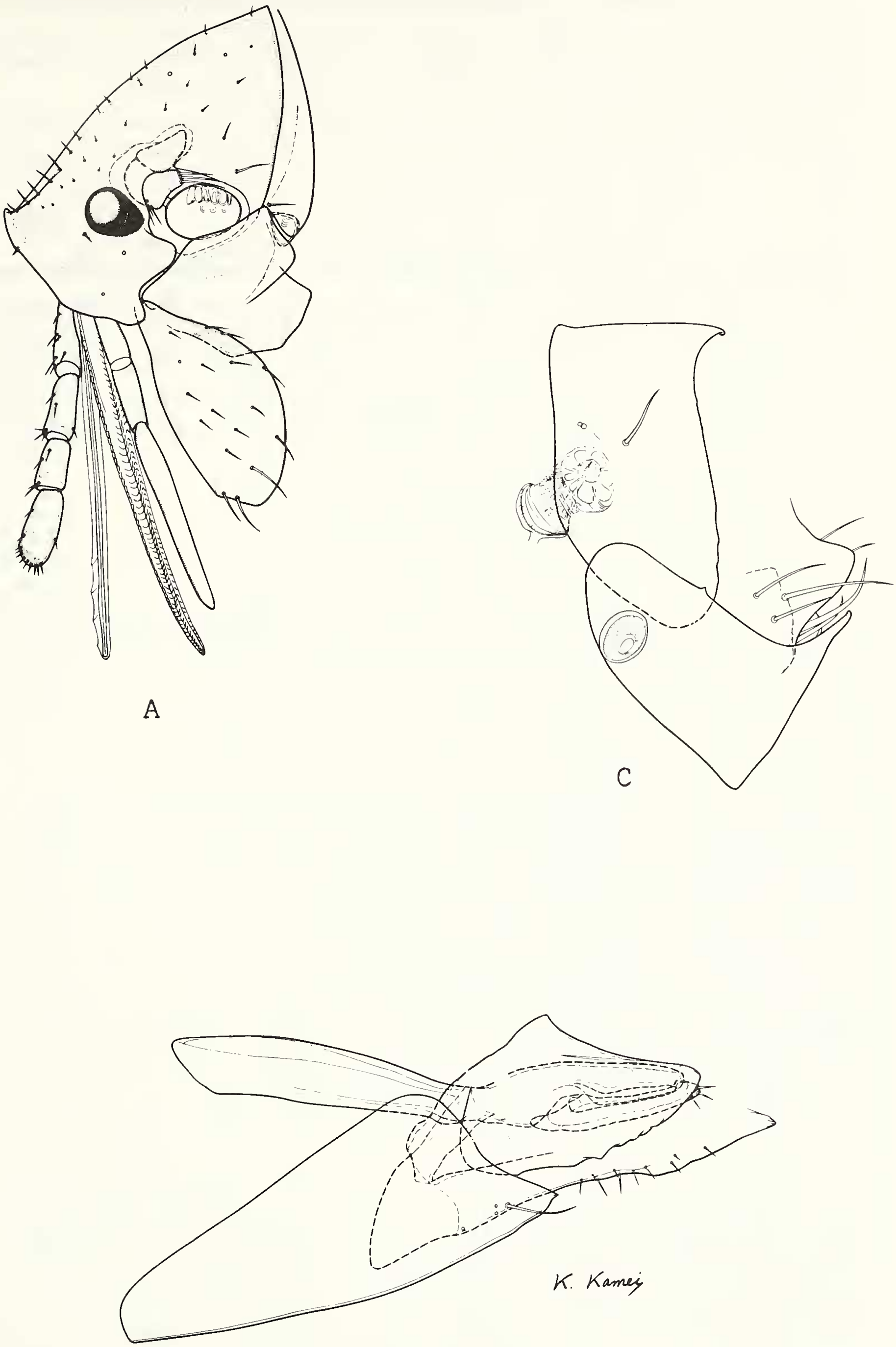


Fig. 44. *Tunga penetrans* (Linnaeus). Male. A. Head, prothorax and procoxa; B. Genitalia. Female. C. Spermatheca and 7th abdominal segment. From "The Fleas (Siphonaptera) of Panama" by Tipton and Méndez, *in* "Ectoparasites of Panama", Field Museum of Natural History, Chicago (1966).

Under special conditions, a flea species that has come in contact with a new host may be able to persist and establish itself, eventually developing extreme specificity. In some instances, special mechanisms of isolation, usually of a geographic character, but sometimes strictly ecological, influences appearance of new forms as a result of speciation.

Accompanying natural host affiliation, temperature, humidity and other ecological considerations are crucial in the dispersion of fleas and other ectoparasites. Climate is probably one of the most important factors that limits distribution of many species. Temperate areas are not only richer in species of fleas than lowlands, but also have a great deal of endemism. (It may be observed in Table 6 that the majority of the flea taxa are concentrated on the high lands of the Andean territory). Of 35 taxa estimated for southwestern Colombia, some 12 species are found in tropical zones (from sea level to 600 meters), while those remaining are typical of temperate or subtropical zones (from 600 to 1,505 meters) and the much cooler montane areas (1,505 to at least 3,050 meters). [1] Certain species found in warm areas are tolerant of a wide range in temperature, as exemplified by *Xenopsylla cheopis* and *Ctenocephalides felis*. Tables 7 and 8 present data on geographic affinities of genera and species respectively.

Table 6. Vertical distribution of Southwestern Colombian fleas.

| Species | Tropical (1 - 600 m) | Subtropical (600 - 1,505 m) | Montane (1,505 - 3,050 m) |
|---|---|---|---|
| *Neotyphloceras rosenbergi* | | X | X |
| *Adoratopsylla (T.) intermedia* | X | X | X |
| *Ctenidiosomus traubi* | | | X |
| *Ctenidiosomus rex* | | | X |
| *Cleopsylla monticola* | | | X |
| *Sphinctopsylla tolmera* | | | X |
| *Plocopsylla phyllisae* | | | X |
| *Plocopsylla thor* | | | X |
| *Sternopsylla distincta* | | | X |
| *Leptopsylla segnis* | | | X |
| *Dasypsyllus gallinulae* | | | X |
| *Pleochaetis equatoris* | | | X |
| *Pleochaetis smiti* | | | X |
| *Tetrapsyllus comis* | | | X |
| *Polygenis bohlsi* | | X | X |
| *Polygenis caucensis*, n. sp. | X | X | |
| *Polygenis delpontei*, n. sp. | | X | X |
| *Polygenis dunni* | X | X | |
| *Polygenis hopkinsi*, n. sp. | | | X |
| *Polygenis klagesi* | X | X | |
| *Polygenis pradoi* | | | X |
| *Polygenis roberti* | X | X | |
| *Polygenis thurmani* | | | X |
| *Polygenis trapidoi*, n. sp. | | | X |
| *Scolopsyllus colombianus* | | | X |
| *Rhopalopsyllus australis* | X | X | X |
| *Rhopalopsyllus cacicus* | X | X | |
| *Rhopalopsyllus lugubris* | X | X | |
| *Xenopsylla cheopis* | X | X | X |
| *Ctenocephalides felis* | X | X | X |
| *Pulex irritans* | X | X | X |
| *Pulex simulans* | | | X |
| *Rhynchopsyllus pulex* | | X | X |
| *Tunga penetrans* | X | X | |

1. The altitudinal distribution used here follows Wenzel and Tipton (1966).

Table 7. Geographic affinities of the genera of Southwestern Colombian fleas.

| SIPHONAPTERA (Generic level) | Cosmopolitan | Nearctic-Neotropical | Neotropical Lowlands | | | Neotropical Highlands | |
|---|---|---|---|---|---|---|---|
| | | | Pacific coastal South America | Panama and Central America | Orinoco and Amazon basins | Andean only | North America and Andean |
| *Neotyphloceras* | | | | | | X | |
| *Adoratopsylla* | | | X | X | X | | X |
| *Ctenidiosomus* | | | | X | | X | |
| *Cleopsylla* | | | | | | X | |
| *Sphinctopsylla* | | | | | | X | |
| *Plocopsylla* | | | | X | | X | |
| *Sternopsylla* | | X | | X | | | X |
| *Leptopsylla* | X | X | | | | | X |
| *Dasypsyllus* | X | X | | X | | | X |
| *Pleochaetis* | | X | | X | | X | |
| *Tetrapsyllus* | | | | | | X | |
| *Polygenis* | | X | X | X | X | | X |
| *Scolopsyllus* | | | | | | X | |
| *Rhopalopsyllus* | | X | X | X | X | | X |
| *Xenopsylla* | X | X | X | X | X | | X |
| *Ctenocephalides* | X | X | X | X | X | | X |
| *Pulex* | X | X | X | X | X | | X |
| *Rhynchopsyllus* | | X | X | X | X | | X |
| *Tunga* | X | X | X | X | X | | X |

Since the evolution of fleas to some degree has paralleled that of their hosts, the origin and dispersal of these mammals can often be indicative of distribution of fleas. From arguments of some authors, notably Hershkovitz (1967) and Tipton and Wenzel (1966), it seems probable that small mammals, particularly cricetine rodents, dispersed recently (Miocene or earlier) from Middle to South America. It is likely that their fleas evolved and radiated accordingly. Today, several genera of fleas, belonging mainly to the families Ceratophyllidae and Hystrichopsyllidae, are associated with these rodents. Adaptive radiation of some Neotropical rodents seems to have strongly influenced the evolution of their fleas. For example, the flea *Kohlsia falcata* Méndez and Hanssen, which occurs in Colombia, and *K. tiptoni* Méndez and Altman, a closely related Central American species, have developed (among characteristics not shared with other *Kohlsia*) a tibial comb of spines on all legs. Since the two species are associated with some mammals (squirrels and other rodents) that are either completely or partially arboreal, it appears likely that their peculiar adaptations are linked to activities or features of their hosts.

The genus *Kohlsia* is believed to have originated in Middle America. Most species of this ceratophyllid group live in Central America and Mexico, while only two species are known from South America (not further south than Colombia and Ecuador). This fact may indicate recent invasion of the genus to this part of the continent. A similar pattern of dispersal is found in the related genus *Pleochaetis*. This group appears to have originated in and dispersed from Middle America as typical parasites of the simple-penis-type cricetine rodents (discussed by Hershkovitz, 1966), specifically *Peromyscus*. It is noted that some complex-penis-type cricetines, such as *Oryzomys* and *Thomasomys*, harbor fleas of the genus *Pleochaetis*, possibly as secondary hosts. At the present time, species of *Pleochaetis* are distributed from southwestern United States to northern South America, but are concentrated in Middle America.

Table 8. Geographic affinities of the species of Southwestern Colombian fleas.

| SIPHONAPTERA (Specific level) | Cosmopolitan | Nearctic-Neotropical | Neotropical Lowlands | | | Neotropical Highlands | |
|---|---|---|---|---|---|---|---|
| | | | Pacific coastal South America | Panama and Central America | Orinoco and Amazon basins | Andean only | North America and Andean |
| *Neotyphloceras rosenbergi* | | | | | | X | |
| *Adoratopsylla (T.) intermedia* | | | X | X | X | X | |
| *Ctenidiosomus traubi* | | | | | | X | |
| *Ctenidiosomus rex* | | | | | | X | |
| *Cleopsylla monticola* | | | | | | X | |
| *Sphinctopsylla tolmera* | | | | | | X | |
| *Sphinctopsylla diomedes* | | | | | | X | |
| *Plocopsylla phyllisae* | | | | | | X | |
| *Plocopsylla thor* | | | | | | X | |
| *Sternopsylla distincta* | | X | | X | | | X |
| *Leptopsylla segnis* | X | X | | | | | X |
| *Dasypsyllus gallinulae* | X | X | | X | | | X |
| *Pleochaetis equatoris* | | | | | | X | |
| *Pleochaetis smiti* | | | | | | X | |
| *Tetrapsyllus comis* | | | | | | X | |
| *Polygenis bohlsi* | | | | | X | X | |
| *Polygenis caucensis*, n. sp. | | | X | | | | |
| *Polygenis delpontei*, n. sp. | | | | | | X | |
| *Polygenis dunni* | | | | X | X | | |
| *Polygenis hopkinsi*, n. sp. | | | | | | X | |
| *Polygenis klagesi* | | | X | X | X | | |
| *Polygenis pradoi* | | | | | X | X | |
| *Polygenis roberti* | | | | X | X | | |
| *Polygenis thurmani* | | | | | | X | |
| *Polygenis trapidoi*, n. sp. | | | | | | X | |
| *Scolopsyllus colombianus* | | | | | | X | |
| *Rhopalopsyllus australis* | | | | X | X | | |
| *Rhopalopsyllus cacicus* | | | X | X | X | | |
| *Rhopalopsyllus lugubris* | | | X | X | X | | |
| *Xenopsylla cheopis* | X | X | X | X | X | | X |
| *Ctenocephalides felis* | X | X | X | X | X | | X |
| *Pulex irritans* | X | X | | X | X | | X |
| *Pulex simulans* | | X | | X | X | | |
| *Rhynchopsyllus pulex* | | X | | X | X | | X |
| *Tunga penetrans* | X | X | X | X | X | | |

The flea fauna of the lowlands of Colombia is very similar to those of Panama and the Amazon and Orinoco basins. (Fleas which indicate this pattern are *Adoratopsylla (Tritopsylla) intermedia, Polygenis klagesi, P. dunni, P. roberti beebei, Rhopalopsyllus australis, R. cacicus* and *R. lugubris*). This can be explained on the basis of shared species or related forms of mammal hosts, and absence now of effective barriers that might have prevented faunal interchange in remote times. Conversely, the striking mammalian relationship that exists between the Central and Western Cordilleras in Colombia and the Ecuadorian mountains is correlated with the affinity found in the flea fauna. Species such as *Cleopsylla monticola, Sphinctopsylla tolmera, Plocopsylla phyllisae, Pleochaetis smiti, P. equatoris* and *Tetrapsyllus comis*, are examples of this similarity in the northern Andes.

In the southwestern Colombian fauna, coexistence of two or more flea species on the same host is prevalent, and, in general, host specificity is not highly developed. Exceptions are *Sternopsylla distincta* and *Rhynchopsyllus pulex*, restricted to bats. Even in such cases, no single bat species is the only host for any of these flea species. It is reasonable to assume that these two bat fleas originated sometime during or after the Oligocene from the northern half of South America, where the hosts probably evolved.

Of the cosmopolitan fleas found in southwestern Colombia, *Xenopsylla cheopis* and *Ctenocephalides felis* are native to the Ethiopian Region. *X. cheopis* has been introduced into many areas of the world with murine rodents, especially with *Rattus* and *Mus*; however, it has also been found on a broad range of hosts. The so-called cat flea, *Ctenocephalides felis*, is probably the most widespread and least host discriminating species in Colombia, although it has a particular preference for the domestic cat and other carnivores. *Leptopsylla segnis* is likely to have been derived from the Oriental Region (Hopkins and Rothschild, 1971) from where it has spread to different regions of the world, primarily carried by its principal host, the house mouse, *Mus musculus*. There is a strong possibility that *Pulex irritans*, a world wide flea, is derived from the Nearctic Region. *Pulex simulans* (which is primarily restricted to America), as well as the other species of the genus, also could have the same origin. Both species of *Pulex* are sometimes associated with humans and other mammals, but they apparently prefer carnivores and rodents, respectively.

*Dasypsyllus gallinulae perpinnatus* occurs in South America, being derived from the nominate form, probably Holarctic in origin. Probably this flea, similar to other bird fleas, evolved on a mammal host (perhaps an arboreal member of the family Cricetidae or Sciuridae). Apparently during special circumstances, when a bird host is not available, fleas of this species readily attach to a mammal, occupying a similar ecological niche.

Other fleas, e.g. *Ctenidiosomus*, which originated in South America, might have evolved on cricetine rodents when the latter became fully established on this portion of the continent, or were early parasites of caviomorphs or opossums. This genus is especially interesting because it is the only South American group of the more typical Old World family Pygiopsyllidae, which is prevalent in the Australo-Malayan Subregion. An undescribed species of this genus, from Middle America (Wenzel and Tipton, 1966), is interpreted as an invader from northern South America.

*Tunga penetrans* is another authentic South American flea, which probably first became parasitic on rodents. During the interim, however, it became more selective for larger and more ideal hosts, such as *Sus scrofa, Homo sapiens* and other large mammals. The genus *Tunga* has an interesting, discontinuous distribution. While five species are typically Neotropical and originated in the Brazilian Subregion, one species occurs in Baja California, and in the Rocky Mountain Subregion of the Nearctic Region. Both remaining known species of *Tunga* are confined to the Manchurian Subregion of the Palearctic Region; one is present in China and the other in China and Japan.

It is possible that the primitive helmet fleas of the family Stephanocircidae were originally exclusive parasites of marsupials (Hopkins, 1957; Johnson, 1957; Jordan, 1931). The Australian representatives of the family, the genera *Coronapsylla* Traub and Dunnet and *Stephanocircus* Skirse, included in the subfamily Stephanocircinae, apparently originated on marsupials, but later have also become associated with murids. On the other hand, American helmet fleas constitute the subfamily Craneopsyllinae and are secondarily adapted to rodents of the family Cricetidae, which apparently are more suitable hosts than marsupials on this continent. The genera *Cleopsylla, Plocopsylla* and *Sphinctopsylla*, the stephanocircid groups in Colombia, are more characteristic of complex type cricetine rodents. They are predominantly Andean fleas; however, one species, *Plocopsylla scotinomi* Tipton and Méndez is known from Panama. This

fact seems to indicate that the genus reached Central America in more recent times. *Cleopsylla* (the most primitive craneopsylline), and *Sphinctopsylla*, are apparently restricted to South America, where they seem to be indistinctly associated with the terrestrial marsupial *Caenolestes* and with some cricetines, such as *Akodon, Oryzomys, Phyllotis,* and *Thomasomys*. The remaining craneopsyllines have not yet been reported from Colombia: *Craneopsylla* Jordan, *Barreropsylla* Jordan, *Tiarapsylla* Wagner and *Nonapsylla* Wagner. As with their relatives, they might have been more linked to marsupials in the past; nevertheless, in recent times, their relationship with rodents appears more evident.

*Didelphis marsupialis, Metachirus nudicaudatus* and other marsupials are normal hosts for *Adoratopsylla intermedia*, concluded to be of South American origin. Although this flea is sometimes found on *Oryzomys* and additional cricetine rodents, it is obvious that it has marked specificity for opossums and became associated with them throughout their evolution. *A. intermedia* accompanied *D. marsupialis* when this opossum invaded North America after the Isthmian connection during the late Tertiary, and is presently found as far north as Mexico.

*Neotyphloceras rosenbergi*, another tropical South American flea, appears to be secondarily associated with opossums, since it has preference for a variety of cricetine rodents, especially members of the complex-penis-types, *Oryzomys, Sigmodon, Akodon,* and *Thomasomys*.

Rhopalopsyllidae is the most characteristic flea family of Colombia, and in the American tropics and subtropics. Evidence from host-parasite relationships and distribution of this group suggest that it originated in South America, in association with caviomorph rodents. These are older on this Continent, and on which some of the rhopalopsyllids are presently found. The fossil records indicate either a South American origin for the caviomorphs (Hooper, 1949), or at least invasion by their precursors from elsewhere in the Early Oligocene, as suggested by Patterson and Pascual (1972). If rhopalopsyllids began as parasites of caviomorphs, they later gradually lost their preference for these rodents and became established on a variety of cricetine hosts, particularly of the compex-penis-type. The basis for this is that this group of fleas does not demonstrate significant host specificity. The only Parapsylline genus that has been thus far found in southwestern Colombia is *Tetrapsyllus*, an Andean genus whose origin is probably correlated with the final uplift of the Andes at the end of the Tertiary. These fleas seem to show some preference for *Oryzomys, Phyllotis, Ctenomys, Rattus* and other rodents. With the exception of *Tiamastus*, the remaining taxa of the subfamily Rhopalopsyllinae, *Polygenis, Rhopalopsyllus,* and *Scolopsyllus*, have been collected in southwestern Colombia.

The genus *Polygenis,* by far the dominant rhopalopsyllid group, has experienced considerable radiation and more than fifty forms are known today. It appeared in some area of the Brazilian Subregion, which might have well been in the territory presently occupied by Brazil. Despite the large assortment of animals found infested with *Polygenis*, its principal hosts are myomorph and caviomorph rodents. According to Wenzel and Tipton (1966), endemic species of *Rhopalopsyllus* and *Polygenis* in Middle America may be explained on the basis of an early, pre-Pleistocene dispersal of cricetine rodents from South America. Members of the genus *Rhopalopsyllus* are distributed among a variety of hosts; however, some patterns of selectivity are noticed in the species found in Colombia. *R. australis* and *R. lugubris* appear to be more prevalent in caviomorph rodents while *R. cacicus* more regularly seems to favor armadillos.

The most distinct evidence of endemicity in southwestern Colombian fleas is given by the monotypic rhopalopsyllid genus *Scolopsyllus*, which seems to be primarily associated with *Oryzomys* and appears to be confined to certain mountains surrounding the Cauca Valley. Present data suggest a recent genesis of this flea under isolated ecological mechanisms of unknown nature. The fact that the Colombian mountains have been insufficiently explored for mammals and their ectoparasites offers the possibility that other interesting endemic taxa remain to be found.

It may be concluded that much remains to be learned about the fleas of southwestern Colombia and their host relationships. Much information is also needed on their vertical, latitudinal and seasonal distribution, as well as on other important features. In this region of Colombia, as in other areas of South America and the rest of the world, information on Siphonaptera is incomplete. However, future studies should not be limited to completing the taxonomic gaps, but also be focused on obtaining knowledge of the mechanisms of competitive displacement among the different species and their niche preferences, and about the biotic requirements of these parasites and their interrelationship with physiological, morphological and behavioral features of the hosts and their environment. It is known that the range of many fleas does not correspond exactly to that of their host range; however, an understanding of the host range contributes to fundamental information on flea ecology and distribution, and in some instances offers a favorable pattern for control activities, important particularly in dealing with effective plague vectors. A knowledge of natural regulation of flea populations and the seasonal abundance of these insects also contributes to this objective and helps to clarify why some species are more successful than others in maintaining their existence on the host through competition and adaptation.

## ACKNOWLEDGEMENTS

The guidance, encouragement and valuable suggestions by Rollin H. Baker, Director of the Museum, Michigan State University, are deeply appreciated. I wish to thank Harold D. Newson, James W. Butcher, and Marvin H. Hensley of Michigan State University and David C. Baerg and Richard N. Rossan of Gorgas Memorial Laboratory for their assistance and critical review of the manuscript. Advice and support were also given by Martin D. Young and Pedro Galindo V., former and present Director, respectively, of Gorgas Memorial Laboratory.

This work could not have been undertaken without the cooperation of Harold Trapido, who submitted the basic material and continued to support the project following the termination of his assignment with the Rockefeller Foundation in Colombia.

I wish to express my sincere thanks to Alvaro Dueñas and Maurice Thomas for authorization to use information pertaining to mammal specimens deposited with the Departamento de Microbiología, Universidad del Valle. Dr. Thomas has been kind enough to collaborate in other aspects of this work and has donated material.

Alberto D'Alessandro and other authorities, Pablo Barreto, Stephen Ayala, and José I. Borrero, of the International Center for Medical Research and the Universidad del Valle, as well as Vernon E. Thatcher, formerly with these institutions, have contributed in several aspects to my investigations.

Eric C. Wells, head of the Animal Health Program of the Centro Internacional de Agricultura Tropical at Palmira, and David E. Evans of the same unit, have provided flea specimens and needed information.

I am indebted to Hugh Tyndale-Biscoe of the Australian National University, Canberra, for the loan of Colombian flea material obtained in connection with his research on South American marsupials.

F.G.A.M. Smit of the British Museum Department of Entomology kindly examined specimens of the new taxa of *Polygenis* and confirmed their status as undescribed species.

Assistance in field activities at Departamento del Valle was given by Lucio Velásquez and Jairo Ardila, who are with the International Center for Medical Research.

Oscar A. González C., Bagardo Materón Narvaez and Jaime Vargas of the Corporación Autónoma Regional del Cauca helped make possible our trip to Alto Anchicaya and afforded facilities for which I am indebted. Thanks are expressed to Harold Graham for the hospitality

offered us during the collecting trip to Lago Calima.

I would like to thank George E. Ball for his interest in this paper and the fine editorial efforts that made possible its publication.

Other persons who have assisted in this work are too numerous to be listed individually. To each of them, I express my gratitude for their contribution toward the completion of this work.

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